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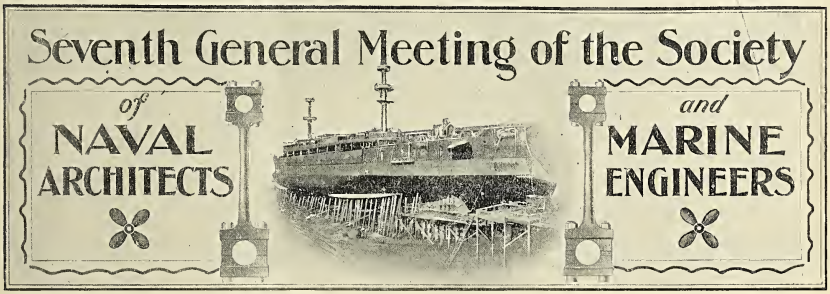

FROM shipbuilding centers as widely apart as San Francisco and London representatives of both the naval and merchant branches of the profession gathered at the seventh general meeting of the Society of Naval Architects and Marine Engineers, November 16 and 17. This, as is customary, was held in the auditorium at engineering headquarters, 12 West 31st St., New York. There was a spring tide attendance, so that at the opening sessions informal overflow meetings were held in the assembly room, where acquaintanceships were renewed and the chances for debate were unrestricted. Some of the veterans were missing, but this was not surprising in these days of foreign active service and phenomenal shipbuilding activity at home. Even the President of the Society had to send his regrets across from the other side of the ocean, where matters connected with the expansion of shipping facilities had called him. In point of numbers there were substitutes, however, for all the absentees, and many unfamiliar faces betokened the vigorous growth of the Society. To Rear-Admiral F. M. Bunce, U. S. N., was assigned the honor of calling the meeting to order at the opening session.

ANNUAL REPORT OF SECRETARY-TREASURER.

Business matters occupied the attention of the members at the opening. The annual report of Secretary-Treasurer Francis T. Bowles, which had been indorsed by the Council, was presented for approval. This showed that at the date of the report, November 15, there were 573 members of all classes on the rolls. During the year twelve deaths had occurred, as follows:

George A. Barnard,
Frank H. Conant,
Jacob C. Cramp,
Sumner C. Paine,
W. Louis Sonntag, Jr.,
Frank Thomson,
R. B. Dashiell,
Alf. A. Dietrich, Germany
Robert R. Leitch,
William H. Webb,
Charles P. Willard,
Thomas W. Hyde.

Five resignations had been acted upon, as follows:

Members.
Leopold Beck,
Charles A. E. King,
George B. Whiting.

Associates.
Benjamin H. Cramp.
William Swift.

Delinquent members numbered thirty-eight, their dues amounting to $268. A number of sales of back volumes of the Transactions were reported. The financial statement showed that the Society is prosperous. Receipts for the year were $5,614.76, which, added to the balance from the year previous, gave a total of $9,256.36. Expenditures for the year footed up $5,669.64, leaving a cash balance of $3,586.75 to carry forward. Resources, including fees due, volumes of Transactions, furniture, and cash invested and on hand, amount to $13,935.50, and the liabilities a minus quantity. By unanimous vote the report was approved.

ADMISSIONS TO MEMBERSHIP.

Many applications for membership in the several classes had been received and acted upon by the Council, and these were now presented to the meeting and a vote taken as follows:

Members—Arthur W. Ayer, Professor Mechanical Engineering, University of Vermont; Thomas W. Bristow, Consulting Ship Builder and Marine Expert, Cleveland; William F. Carnes, Assistant Superintending Engineer in charge of drawing rooms, Harlan & Hollingsworth Co.; George J. Carter, Manager Elswick Ship Yard; Sir W. G. Armstrong, Whitworth & Co., Ltd.; William G. Coxe, Guarantee Engineer, Wm. Cramp & Sons Co.; Robert K. Crank, Lieutenant U. S. N.; William Hessel

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Marius de Gelder, Manager, L. Smit & Zoon Ship and Engine Building Works, Holland; William E. Elliott, Chief Engineer, Goodrich Transportation Co., Chicago; Eric H. Ewertz, Chief Constructor, Crescent Ship Yard; William Gatewood, Draughtsman, Wm. Cramp & Sons Co.; Elias Gunnell, Superintendent, Chicago Ship Building Co.; H. S. Hodge, President, Samuel F. Hodge & Co., Detroit; Carl O. Liljegren, Designer, Newport News Co.; Luther D. Lovekin, Chief Draughtsman, engine department, Wm. Cramp & Sons Co.; Alexander J. Maclean, Professor Naval Architecture, Webb's Academy; Henry Penton, Superintending Engineer, Chicago Ship Building Co.; William M. C. Philbrick, Draughtsman, Navy Yard, Portsmouth; Henry S. Ross, Captain, U. S. N.; John Roberts Sherwood, Vice-President and General Manager, Baltimore Steam Packet Co.; Harry G. Skinner, President, Wm. Skinner & Sons' Ship Building and Dry Dock Co.; Francis H. Stillman, proprietor the Watson-Stillman Co.; Gustave R. Tuska, Chief Engineer, Panama Railroad and Panama Steamship Line; Ogle T. Warren, Chief Draughtsman, Chicago Ship Building Co.; Philip Watts, Naval Architect and Managing Director, Elswick Ship Yard, Sir W. G. Armstrong, Whitworth & Co., Ltd.; Herman Wellenkamp, Royal Marine Shipmaster, Kiel, Germany; Alfred Westmacott, Assistant Constructor, Elswick Ship Yard, Sir W. G. Armstrong, Whitworth & Co., Ltd.; Charles J. F. M. Lilliehook, Professor of Naval Architecture, Royal Technical School, Stockholm; Herbert C. Sadler, Assistant Professor of Naval Architecture. University of Glasgow; Robert Curr, marine surveyor; Cleveland; Robert C. Monteagle, Chief Draughtsman, Burlee Dry Dock Co.; Charles E. Ward, Superintendent, Ward Engineering Works; Carroll S. Smith, New York Agent, William Cramp & Sons, S. & E. B. Co.; Howard Patterson, President New York Nautical College, New York; Mark Fargusson, in charge hull work, C. D. Mosher; Arthur Masters, Leading Draughtsman, Crescent Ship Yard; Friedrich Zeiter, Lecturer on Marine Engineering at Technikum, Bremen.

Advanced from Associate to Member—M. S. Chace, Assistant Inspector of Battleships, Newport News; Frederick Pomeroy Palen, Draughtsman in charge of Engine Department, Newport News Co.; William A. Fairburn, Chief Draughtsman, Bath Iron Works; Daniel C. Nutting, Assistant Naval Constructor, U. S. N.; Gowen Brooks, Chief Draughtsman, U. S. N., Bath Iron Works; Theodore Lucas, Calculating Draughtsman, Cramp's Ship Yard, Philadelphia.

Associate Members—Ernest A. Allan, Draughtsman, Bureau Construction and Repair, Navy Department; George E. Barrett, Draughtsman, Marine Department, Newport News Co.; Ralph E. Barry, Lieutenant, United States Navy, retired; Robert J. Boyd, Draughtsman, United States Navy, Geo. Lawley & Son, Corp.; Herbert Burton, Assistant Draughtsman, United States Navy, Columbian Iron Works; C. S. Butts, Draughtsman, Naval Station, Port Royal; H. G. Dalton, Pickands, Mather & Co., Cleveland; W. G. DuBose, Assistant Naval Constructor, U. S. N.; J. W. Duntley, President Chicago Pneumatic Tool Co.; Louis Eckert, Calculating Draughtsman, with Tams & Lemoine; E. F. Eggert, Assistant Naval Constructor, United States Navy; A. W. Goodrich, President Goodrich Transportation Co.; William G. Groesbeck, Assistant Naval Constructor, United States Navy; Albert R. Jackson, Engineer United States light house service; Alexander Kearny, Assistant Engineer of motive power Pennsylvania R. R. Co.; Otto B. Keller, with Keufell & Esser Co.; Gontran de Faramond de Lafajole, Lieutenant French Army; George E. Lawrence, Ship Draughtsman, Wm. Cramp & Sons Co.; William G. Mather, President Cleveland Cliffs Iron Co.; W. W. Meek, Draughtsman, United States Navy, Newport News Co.; L. T. Myers, Vice-President, Wm. R. Trigg Co.; W. C. Nickum, Leading Draughtsman, hull office Wm. Cramp & Sons Co.; Bernard F. O'Connor, New York; Charles L. Ottley Captain British Royal Navy; Hubert von Rebeur Paschwitz, Captain-Lieutenant, Imperial German Navy; Joseph W. Powell, Assistant Naval Constructor, United States Navy; W. G. Randle, Superintendent New York Ship Building Co.; J. R. Raymond, Secretary and Manager, Standard Automatic Releasing Hook Co.; Ernst F. Rossow, Draughtsman, Navy Yard, Mare Island; Henry H. Schulze, Draughtsman, Wm. R. Trigg Co.; H. T. Sloan, Engine Draughtsman, Pennsylvania R. R. Co.; Godfrey L. Smith, Scientific Department, Newport News Co.; Edward G. Todt, Chief Draughtsman, Engine Department, Chicago Ship Building Co.; G. R. Townsend, Draughtsman, Engine Department, Wm. R. Trigg Co.; B. W. Wells, Jr., Lieutenant United States Navy; A. B. Wolvin, General Manager American Steamship Co., Duluth; W. R. C. Wood, Hull Draughtsman, Navy Yard, New York; Allen D. Woods, Draughtsman, with Tams & Lamoine; William L. Wright, Assistant Draughtsman, United States Navy, Maryland Steel Co.; R. P. Adams, Draughtsman, Navy Yard, Norfolk; Theodorus S. Bailey, Draughtsman, United States Navy, Crescent Ship Yard; Thomas W. Battin, Chief Draughtsman, naval work, Newport News Co.; William B. Callison, Hull Draughtsman, Navy Yard, New York; W. S. Doran, Manager Marine Department, H. R. Worthington Co., Philadelphia; Isaiah C. Hanscom, Draughtsman, Navy Yard, Portsmouth; Edward McIntyre, Superintendent Spedden Ship Building Co.; Lucius M. Michael, Draughtsman, United States Navy, Harlan & Hollingsworth Co.; Isaac B. Mills, 156 Cypress street, Brookline, Mass.; Harold F. Norton, Draughtsman, United States Navy, Newport News Co.; J. W. L. Waters, Steel Hull Surveyor; Thomas E. Webb, Jr., Hull Draughtsman, Navy Yard, New York; John R. Gause, Assistant Constructor, hull department, Harlan & Hollingsworth Co., Wilmington, Del.; Henry S. Reed, with the Keasbey & Mattison Co.; Robert L. Ireland, Vice-President, American Ship Building Co., Cleveland; Charles Ackerman, Assistant Manager, Crescent Shipyard; William W. Ackerman, Secretary-Treasurer, Samuel F. Moore Sons Co.; Thomas Dolan, Director, William Cramp & Sons S. & E. B. Co.; George N. Gardiner, Member, George N. Gardiner & Sons; Charles Longstreth, V. Pt., U. S. Metallic Packing Co., Philadelphia; Maeston Niles, United States Navy, retired; Harrison I. Cole, Ship Draughtsman, Navy Yard, Boston, Mass.; Nicholas Cushing, Draughtsman, Crescent Shipyard; George B. Martin, Secretary, Crescent Shipyard; John E. Walsh, General Contractor; Frank P. Lewis, Master Electrician, Construction Department, Navy Department, New York.

Juniors—W. R. Ballard, Assistant Draughtsman,

United States Navy, Union Iron Works; W. R. Bean, Draughtsman, Newport News Co.; Louis A. Brooks, Draughtsman, United States Navy, Newport News Co.; L. D. Fisher, Draughtsman, Newport News Co.; Walter E. Kimball, Assistant Draughtsman, United States Navy, Fore River Engine Co.; James W. McCormack, Draughtsman, Navy Yard, New York; William S. Newell, Assistant in Marine Engineering, Massachusetts Institute of Technology; E. E. Pierce, Draughtsman, Newport News Co.; James J. Salmond, Assistant Editor, American Machinist; D. Stuart, Draughtsman, hull department, Delaware River Iron Ship Building Works; Edgar P. Trask, Draughtsman, Scientific Department, Newport News Co.; W. A. White, Ship Draughtsman, Newport News Co.; Frederick C. Whitehouse, Draughtsman, Navy Yard, New York; Charles Winterburn, Draughtsman, Navy Yard, Portsmouth; Walter S. Leland, Assistant Draughtsman, Navy Yard, Boston, Mass.; Stephen B. Boyd, Assistant Ship Draughtsman, Navy Yard, Boston, Mass.; Horace E. Setchell, Draughtsman, Engineering Department, Wm. Cramp & Sons S. & E. B. Co., Philadelphia; Eads Johnson, Draughtsman, Crescent Ship Yard; Austin E. Overmon, Copyist Draughtsman, Navy Yard, Boston, Mass.

It will be noticed that many foreign applications were received, including that of Philip Watts, the distinguished naval architect and managing director of the Elswick shipyard of Armstrong, Whitworth & Co., Captain Lonzdale Ottley of the British Navy, and residents of France, Germany and Holland. Applications from home centers represented very varied interests, coming from shipowners, shipbuilders, naval officers, designers, instructors, members of the technical staffs of various yards, and engineers in charge of construction and operation. This was a substantial evidence of the increasing interest now being taken in the higher development of the art, and the steady growth in membership and influence of the Society. Considerably more than 100 applicants in all were admitted to membership, and this brings the total membership up to 694 for all classes.

ELECTION OF OFFICERS, ETC.

Election of officers was next on the programme, and Mr. Ward was called to the chair. Secretary Bowles read the recommendations of the Council, which renominated the existing list of officers, and to fill vacancies occasioned by death named Rear-Admiral W. T. Sampson as First Vice-President and W. I. Babcock as Member of the Council. On the motion of John C. Tawresey the recommendations were unanimously accepted.

Rear-Admiral Bunce having returned to the Chair, resolutions of sympathy and regret touching the death of William H. Webb were introduced by Colonel Edwin A. Stevens, and those referring to the death of General Thomas W. Hyde were presented by Lewis Nixon and spread on the records.

The Chairman then announced the enforced absence of President Clement A. Griscom, who had been called abroad on important business, and in his absence the annual address would be read by the Secretary.

PRESIDENT'S ANNUAL ADDRESS.

"It is with sincere regret that I am obliged to present apologies for absence on this occasion, and to express by disappointment that urgent affairs require my presence in England at a time when I had anticipated the pleasure of taking part in what promises to be a most interesting meeting of your Society.

"This Society, now seven years old, emerges from a period of infancy at a propitious time, and the condition of its affairs is a subject of congratulation. Having been organized with about 430 members and associates, that number, by steady annual increments, has now reached 573, and at this meeting nearly one hundred more will be added to the roll. Your managers believe that the Society is of great value to the profession, and it is certain that the results are obtained at a minimum of expense to the members. It has been a subject of consideration whether the work of the Society could be long continued at the present annual dues, which are so much less than any other society of its class.

"The Society has suffered in this year the loss of its senior founder, that venerable dean of the shipbuilding profession in this country, Mr. William H. Webb, who has always taken part in our affairs with much interest. His achievements as a master of the art, his kindly presence, his devotion to the welfare of his fellow craftsmen, and the education of their apprentices, will long serve as a noble example to the members of this Society.

"Such remarks as it has been my pleasure to address to you from this Chair in past years have been, as I recall them, words of encouragement to progress and diligence in your work under conditions of trade which promised something in the near future but had hardly advanced beyond the state of theory. There is now with us, however, a condition of affairs in shipbuilding which is distinctly one of events and of substantial results.

"The Society will undoubtedly join me in congratulations to one of its members upon the masterful skill shown in the design of a certain yacht, whose record in the international races induces me to characterize this as the olumbia year for naval architects. Yet the immediate prospect of another challenge having its parallel in trade makes it necessary to caution you that all your energies are still required to meet certain conditions still adverse to the shipbuilding interests of our country.

"Whatever may be the political, moral or constitutional aspects of a policy of expansion, it is not without advantages to shipbuilders. The large number of vessels purchased by the Government last year for use of the Army and Navy, together with increasing use of steam vessels in the coasting trade have produced the greatest activity ever seen in our coast shipyards, both on the Atlantic and the Pacific Oceans.

"The orders for large steel steam vessels now taken exceed largely those of any year in our history.

"The record on the Great Lakes is such as to tax the capacity of the shipyards of that district until the fall of 1900. There are now building or to be built on the Lakes 26 steel vessels of large size of an aggregate value of about $8,000,000, and an aggregate carrying capacity of 154,000 gross tons. These vessels comprise one passenger vessel, two steel barges of 7,000 tons capacity each, five steamers of 3,000 tons capacity, suited to trade between the Great Lakes and the Atlantic Seaboard, and 18 steam freight vessels of about 6,000 tons capacity.

"We have also witnessed in the past year the entrance of Lake shipbuilders into the Atlantic trade.

"On the sea coasts we have the unusual condition of nine steamships building for ocean commerce. At least nine large steamers, recently built, have been added to the coasting or West Indian trade in the past year.

This is probably the first occasion that I have found any statistics in regard to American shipping industries of a character desirable to contemplate, and even now I feel obliged to accompany them with a note of warning, "One Swallow maketh not a Summer." The proportion of our export and import trade now carried in American bottoms is too small to be mentioned, and last year was smaller than ever before. To make this percentage a respectable one would require ten times the number of American shipyards working at full time for a number of years. While we have the materials, the tools and mechanics, the successful building of a modern vessel from a commercial point is in reality a triumph of organization of the multitude of diversified trades which it includes. This stage is yet to be reached and can only be attained by regular systematic production. Production depends upon a market and upon traders who see a profit to be made in shipowning under the laws of the United States."

First Technical Session.

The technical sessions were then commenced by the announcement of the chairman of the reading of the first paper:

COALING VESSELS AT SEA.

BY SPENCER MILLER.

This paper gives a brief synopsis of the various efforts in the direction of coaling naval vessels at sea which have been made in recent years, commencing with the plan of Lieutenant R. S. Lowry, R.N., in 1883, and ending with the method proposed by the author. Lieutenant Lowry employed special coal boxes, each of about one ton capacity and provided with an air tight chamber, so that it would float. The boxes were to be passed from the collier to the warship by lines, hoisted, emptied and returned. Later Lieutenant Bell, R.N., proposed a plan to fill the following requirements: Rapidity; safety; ability of the ships engaged in the operation to proceed with the minimum diminution of speed; necessity of keeping coal dry; minimum of labor to be employed; little cost for material necessitated. In the plan proposed by Lieutenant Bell, the collier would first be taken in tow by the warship; then inclined and elevated cables would be attached low down to the rear mast of the warship, and to the top of the foremast of the collier. On the elevated line a truck containing about five bags of coal would be run out to the war vessel and returned when empty, the to and fro movements of the truck being controlled by attached lines. The coal would he hoisted from the hold of the collier to the point of loading into the truck. In discussion, at the time, objection had been made to this system because of the lack of means for maintaining a uniform tension upon the elevated cable. "By the ships pitching toward each other the coal bags would likely be dropped into the sea," says the author, "and by pitching away from each other, either the foremast of the collier would be unshipped or the suspended cable snapped." A plan proposed by Lieutenant Tupper, R.N., contemplated the use of an endless chain passing from the collier to the warship and carrying baskets of coal, but this was subject to the same criticism as the plan of Lieutenant Bell. The plan of Philip B. Low, patented in 1893, was put to practical test by the U. S. Navy Department, the old U. S. S. *Kearsarge* being used in place of a collier to coal the U. S. S. *San Francisco*. This plan the author describes as practically the same as that proposed by Lieutenant Bell, R.N., but with the addition of a counterweight attached to the end of the elevated carrying cable, to maintain a constant tension. The test was made in a calm sea, the vessels being about 200 ft. apart. A counterweight weighing 1,600 lbs. was employed and the coal was contained in 200 lb. bags. The time of hoisting and sending 10 bags was 20 minutes, or at about the rate of 2 to 2 2-3 tons per hour. After the test the Naval Board reported that in rough weather the apparatus would not be of great value. Reference is then made by the author to the plan proposed by John E. Walsh, of New York, along somewhat similar lines and employing a counterweight, and he states the belief that "any hoisting device of this kind elevated to any height would be impracticable in a rolling sea." The author next refers to the paper by Lieutenant A. P. Niblack, U.S.N., read at a previous meeting of the society in which that officer appealed "for larger coal capacity and greater facility for getting coal into storage in our warships." He cited coaling records for the U. S. S. *Chicago*, *Charleston* and *Newark*, 30 tons an hours; H. M. S. *Thunderer*, 17 1-2 tons, and H. M. S. *Anson*, 51.6 tons, the latter using a Temperley transporter. Under specially favorable conditions a recent British test gave a record of 150 tons an hour. Following this an outline of the coaling operations of our fleet in Cuban waters is presented by Mr. Miller, giving references to accounts of damage done colliers by collision with the warships when broadside coaling was attempted at sea. He refers also to a dispatch of Admiral Schley, stating the necessity for leaving the harbor of Santiago unguarded and going to Nicholas Mole for the purpose of coaling his ships in smooth water. French experiments with the use of the Temperley transporter for coaling at sea are also referred to briefly, and this is followed by a disquistion by the late Vice-Admiral P. H. Colomb, R.N., on what may be termed briefly the strategical value of coal. In conclusion the author describes his form of conveyor which has been fitted on the U. S. S. *Marcullus*, collier. In operation the collier is taken in tow of the warship leaving a distance of about 300 ft. apart. The collier is fitted with a special form of winding engine located aft of the foremast, and from this a 3-4 in. cable leads to the top of the foremast over a sheave and thence to a sheave supported on shear legs on the warship, and back again to the mast and winding engine of the collier. This engine gives an in and out motion to the rope and to one side of the loop is attached a carriage with a capacity of 700 to 1,000 lbs. of coal. By an arrangement of friction drums the conveying distance between the two vessels is compensated for and a practically uniform tension sustained during the transit of the load. The total tension is expected not to exceed a maximum of 8,000 lbs., and the speed of conveying is about 1,000 ft. per minute. The paper is

accompanied by rough sketches and engravings of the various systems referred to.

DISCUSSION.

There was no general discussion upon this paper. John E. Walsh announced that he had a plan for coaling from a vessel alongside on the same principle, and called attention to a model, which he exhibited, of an apparatus for coaling at the stern.

CAUSES FOR THE ADOPTION OF WATER-TUBE BOILERS IN THE U. S. NAVY.

BY GEORGE W. MELVILLE, ENGINEER-IN-CHIEF, U.S.N.

In opening, the author announces the policy of the Naval Bureau of Steam Engineering—"the general adoption of water-tube boilers for all new vessels of our navy"—and refers to the existence of "a not inconsiderable sentiment in this country against water-tube boilers." Recognition of the seriousness of such a step is shown by the statement that "any important change in design, even of the apparently minor fittings of ships, may involve such risk to vessel and crew as to be unjustifiable unless the device be thoroughly tried beforehand." The author continuing states his desire "to show that the decision to use nothing but water-tube boilers in our future war vessels is a step in advance and a natural step toward the evolution of the perfect fighting machine." As to the water-tube boiler in its existing form the Engineer-in-Chief states it is bad in principle. Pressure is carried inside the tubes—the weakest part—while in the fire-tube boiler the pressure is without the tubes—tending to close a defective tube. Other defects named were: The decrease in amount of water in the boiler; increased difficulty of observing a leak; decreased value of heating surface. Special attention is also called to the fact that all vessels are compromises, and the author says "whether or not water-tube boilers are superior to cylindrical boilers, as boilers simply, if there be a beneficial effect upon the ship as a whole due to the adoption of water-tube boilers, these boilers are essential to the best design." Water-tube boilers are lighter than fire-tube, and of two similar ships fitted with water-tube and fire-tube boilers respectively, the former will be "somewhat the smaller and handier, will have somewhat less draft and will cost less." Little gain in space, but great saving in weight resulted from the employment of water-tube boilers. A few "historical facts" are next set forth, commencing with the use of the old Martin boiler in the U. S. Navy. In later days, U. S. torpedo craft were fitted with water-tube boilers, chiefly of the small bent tube type. Some accidents had occurred, due to carelessness of manufacture and not to defective design. Steam launches also similarly fitted gave much satisfaction, even with unskilled labor, and the record of mishaps was probably no greater than had fire-tube boilers been used. The first large installation of water-tube boilers was in the U. S. S. *Monterey*, which had four round Ward water-tube boilers, and two single ended fire-tube boilers. The water-tube boilers were satisfactory, little trouble was experienced in maintaining the water level and the boilers were retubed twice by the ship's force. A voyage of 8,000 knots was made by this ship, "largely under forced draft" without injury to the water-tube boilers, while combustion chambers of the fire-tube boilers were badly bulged. Installations of Yarrow boilers in the *Nashville* ("fairly successful"), and Babcock and Wilcox boilers in the *Marietta, Annapolis, Chicago* and monitors *Canonicus, Mahopac* and *Manhattan* ("thoroughly satisfactory"), were referred to. In the case of the monitors the water-tube boilers replaced old box boilers, the latter being cut to pieces and passed up the stack, down through which the separate portions of the water-tube boilers were passed in turn, and later assembled below. Ships to be fitted with water-tube boilers include: *Alert, Atlanta, Cincinnati, Wyoming* (Babcock and Wilcox), *Maine* and *Connecticut* (Niclausse), *Missouri, Wisconsin* and *Arkansas* (Thornycroft), and *Florida* (modified Normand). In operation water-tube boilers require ample feed pumps with easy regulation of feed. Heating surface per horse power of 2.4 sq. ft. is, in the author's opinion, as low as it is yet safe to go. As to economy, results from water-tube boilers of the latest design are as good as from the best type of cylindrical boilers. The ratio of heating surface to grate surface has been kept up to at least 40. A previous statement is qualified thus: "Water-tube boilers lose in efficiency when forced, especially those of the straight tube type"—not a matter of great moment in a war vessel, however, which is under forced draft only at maximum speed. No trouble was experienced from salt water or grease in water-tube boilers, and the author does not think impure feed or scale will cause more trouble in water-tube than in fire-tube boilers. Reference is made to the adoption of the water-tube boiler by the British and Japanese navies, and also to reports of failures; no boiler, however, could be properly said to have failed purely as a result of being a water-tube boiler. Failures may come from misuse, but not use. The author then recounts the "advantages" and "disadvantages" of the fire-tube and water-tube types, and refers to the capacity for raising steam quickly possessed by the latter, with the Santiago fight as a text. Higher pressures possible with water-tube boilers gave smaller and safer pipes and fittings and increased the efficiency of the engines. He opposed the use of boilers containing screwed joints in contact with the fire, or cast steel in the pressure parts. Ideal conditions were: straight and large tubes; few joints; no reducing valves; no automatic feed arrangements; ease of repair; lightness, in moderation; large ratio of grate to fire surface for complete boiler plant; large units; grates short, not too wide; thorough mixing of gases; free circulation; tubes not too long, with fire room space for ready removal. As to merchant ships and yachts, the author believes "it is at best a moot question whether cylindrical boilers are not still the best that can be fitted in ocean-going merchantmen."

In the absence of the author the paper was read by Walter M. McFarland, who added an experience of his own in point: "When I was attached to the *San Francisco*, our steam launch boiler blew up. Nobody was injured, and the only damage done was the carrying away of the top of the dome and the canopy of the boat. We had the boiler repaired at Kiel Dockyard, put in a new top to the dome and a few tubes, and used

the same boiler for some time afterward. When we were in England I had the pleasure of taking some of the people connected with *Engineering* out on a trip. After the trip was over and they were safe on shore I told them that that was the boiler which had blown up and had been repaired. It surprised them a good deal."

DISCUSSION.

GEORGE W. DICKIE, of the Union Iron Works, said: "Somehow or another I have generally been placed amongst those who, if they did not actually oppose the introduction of water-tube boilers, lent no help whatever to their introduction. I would like to place myself right with the members of this Society in regard to that. I think I have wrought as hard, as honestly, and as long, as anyone here present for the betterment of water-tube boilers, and am still engaged in that good work. I do not quite like the tone of Admiral Melville's paper. I do not think that when he states that for tactical reasons water-tube boilers have been decided upon as the proper thing for the Navy, that he should make any apology whatever for their introduction. I am sorry that the Admiral should have stated in the paper that in his opinion water-tube boilers were mechanically bad and indefensible. I would not have gone that length even a few years ago. There has been a good deal of acrimonious talk and writing on both sides of the question of the introduction of the water-tube boiler, and I think that the advocates of the water-tube boilers have said as much and written as much in a violent sort of way as those who were most bitterly opposed to them. At a recent meeting of the Institution of Naval Architects one gentleman said that the trouble with Mr. Howden and Mr. Dickie—I don't know why he associated my name with Mr. Howden's—was that they imagined boilers were placed on board war ships for the purpose of generating steam. (Laughter.) Well we will have to admit that we had been laboring under that delusion, and no doubt the raising of steam has some connection, however remote it may be, with the placing of boilers on board ships. The Admiral gives a sort of an Irish rule that no change should be made in design that has not already been successfully made." (Laughter and applanse.)

MR. MCFARLAND: "He is Scotch, you know; he isn't Irish." (Laughter.)

MR. DICKIE: "However, I did not intend to find fault with that, because I think the Admiral is correct (laughter), that there should be a good deal more than the mere wish that the thing should be successful before it is introduced into any vessel. I think that was the Admiral's meaning.

"The Admiral speaks of the safety of the water-tube boiler and its lightness, and our friend Mr. McFarland who read the paper gave an instance of how simple a thing a boiler explosion was, and he spoke about the launch engine of the *San Francisco* that exploded. I am surprised that in these discussions in regard to water-tube boilers that we hear so much of boilers that exploded and did no harm—always with the inference that supposing the other one had exploded, what would it have done?"

MR. MCFARLAND: "I can tell you that, if you want it."

MR. DICKIE: "The other boilers on the *San Francisco* did not explode."

MR. MCFARLAND: "No, sir. I am glad they did not." (Laughter.)

MR. DICKIE: "There is a statement in this paper that I should like to ask some questions in regard to; that is the statement that the *Monterey* made a distance of 8,000 knots practically under forced draught; I presume that that refers to the trip that the *Monterey* made to Callao. Now the *Monterey's* bunker capacity is 200 tons, and she would steam about thirty-eight hours under forced draught, using all the coal that she had, and I can hardly accept the statement that the *Monterey* steamed any great length of time under forced draught during that trip. It is stated that the water-tube boilers did not suffer anything although the Scotch boiler combustion chambers were badly bulged. I think it is an unfortunate association that Scotch boilers sometimes get into, in regard to water-tube boilers. You know we suffer a good deal by being in bad company, and in that case the Scotch boiler may have been in bad company. (Laughter.) But in talking with the various engineers who have served on the *Monterey*, I find that invariably the Scotch boilers were used as auxiliary boilers when the vessel was in port. Unless it was an absolute necessity the water-tube boilers were not used. Before the *Monterey* went on that particular trip her Scotch boilers had been used for a month or two as auxiliary boilers and she may have gone out with them very dirty. The other boilers were not so used, and I understand that they are kept in reserve, and in good order, ready to be lighted up when they are required for the extra power. At the same time the water-tube boilers in the *Monterey*—and we speak of them because they have been quite a long while in the service—have undergone a very large amount of repairs, and they are reported now as requiring total renewal.

"I believe in the expression of the paper in regard to straight tube boilers and also in what has been said by Mr. See in regard to straight tube boilers, that the boiler that will be successful on our seagoing vessels will no doubt have straight tubes. The difficulty of replacing a tube that fails in a bent tube boiler is a very serious matter indeed.

"One point in Admiral Melville's paper that I noticed was that he deprecates the use of reducing valves. I am very much surprised at this, because I tried about two months ago to have them dispensed with on certain vessels and I could not get it done. I believe that a boiler that has to maintain a much higher pressure of steam than that used in the engines should not be used. A boiler to be a success must be able to steam at high pressure and give that steam dry, and the necessity of maintaining a much higher pressure in the boiler than is used in the engines is an evidence of a defect in the boiler that should be guarded against, and I think it can be guarded against.

"All criticism practically, so far as the introduction of these boilers in the Navy is concerned, is disarmed by the statement in the last paragraph of this paper that it has been decided upon for our naval vessels to use water-tube boilers because they give tactical advantages of great moment. I have been thinking a good deal about tactical advantages. I do not know what is meant here by that. I do not think that a vessel steers

any better because fitted with a water-tube boiler. I presume that it refers to the facility of getting steam rapidly when required. And, by the way, there is another point in the paper that may lead to a misunderstanding. In speaking of the conditions in front of Santiago the Admiral states that the *Massachusetts* might have been there and the *Indiana* might have kept up with the *Oregon* if they had been fitted with water-tube boilers. Now that paper has been written for those who know all about it; but these papers go where this thing may not be known. The *Oregon* was not fitted with water-tube boilers, and the inference would be that if the *Indiana* and *Massachusetts* had had water-tube boilers, like the *Oregon*, that they would have done quite as well. I presume that the *Oregon* had steam up and the others had not, and that was the whole matter, and the fact that steam can be readily got up in a water-tube boiler does not mean that a water-tube boiler will be ready for service as quick as steam is got. I think in a water-tube boiler it would be more difficult to get the fires in condition to supply steam for full power than to get the water hot enough to supply steam, and I believe that that is where the difficulty is going to arise. So far as tactical reasons are concerned, I think you step out of the frying pan into the fire, for the fire will then be your reserve of power instead of the boiler. In boilers with a large amount of water, such as the cylindrical boiler, kept under banked fires, the water has heat in it due to the pressure of steam and the engine can be readily started, and there is a few minutes leeway to get the fires in condition. You cannot do so with the water-tube boilers. And it is wonderful the ingenuity that has been displayed for providing all sorts of arrangements in these boilers in case of difficulty with the changing of power that takes place. In boilers we build now we fit them with very elaborate arrangements for putting the fires out in case the engine should be required to be stopped suddenly, or that for any reason steam should not be required. Otherwise the boiler would be empty of water.

"These are the points that have struck me in regard to the paper and the subject is an exceedingly interesting one—interesting, because it is going to play a very important part in the immediate future in regard to ship development. But I would like to state here and now that I do not think that the water-tube boiler that is to take the place, wholly, of the present Scotch boiler has yet come into existence. I think it has yet to be invented. That is my opinion, and I have studied this matter very carefully. The water-tube boiler can be arranged in a vast number of ways. It is covered in its various developments by innumerable patents. There is very little new in most of the boilers that come out. Ten years ago I laid down twenty-one designs for water-tube boilers. At the time that I presented a combination of water-tube and fire-tube boilers to Admiral Melville proposed for the war ships that were then being discussed and for which the plans were being prepared. At that time he was very much opposed to the very idea of a water-tube boiler and would not think even of one-half of the tubes being water-tubes. Out of those twenty-one plans I then prepared, sixteen have been patented since (laughter) and I am very sure that none of them are good." (Applause and laughter.)

Naval Constructor J. J. Woodward called attention to a feature, especially in connection with the use of the water-tube boiler—the need for large fresh water storage. This meant an increase of space so used and an increase of weight also. In the consideration of designs for large installations of water-tube boilers, this called for the most careful attention, not only of the engineer, but the hull designer. It was a matter which affected the question of stability. With water bottoms full, the water would act in a comparatively solid mass, with the center of gravity very low. In the process of emptying the bottoms the water surface would be considerably enlarged, with the result that the metacenter of that body of water would be relatively much higher than the space in which the water was confined. The practical result of beginning to pump out the tanks would be to raise the water from the tank to a position a number of feet above—a condition which might become a very serious matter in a warship.

John Platt in discussion of the paper said: "In referring to the objection made in England to the introduction of the water-tube boiler into the British navy, the Admiral was speaking from the knowledge that a very great deal of exception had been taken there, and that the engineers of the navy had been very seriously attacked for putting so many water-tube boilers into the large ships. There was some ground for that attack from the fact that in quite a number of the large ships breakdowns did take place, and sometimes rather serious ones. This summer I studied the whole matter for four or five months in England and abroad and found out, as nearly as I could, exactly what had taken place. Now it is all based upon the question of the form of boiler used, and I myself have been forced to the conclusion, very much as given forth by Mr. Dickie, that the water-tube boiler which will fulfil all the things we are looking for in a good boiler has not yet been designed. The boilers in England, in the large ships, which have been criticised all the way through, are boilers that fulfil more nearly the requirements as set forth by Admiral Melville—namely, boilers with large straight tubes. There are three of four kinds that have been used in the British navy; one very extensively; the others have only been tried, but in almost all cases they have given trouble. They are straight tube boilers when they are built, but after they have been run—especially if the boilers are ever forced—they are no longer straight tube boilers, and that is the trouble. In a fast battleship or fast cruiser, where you are getting very big power in a limited space, forcing is absolutely necessary; and when you do that with those large tube boilers and they come back, if they have ever been in a heavy sea-way, the tubes are not straight. I know in the case of a number of the British ships that the amount of deflection was very material indeed, and it was this deflection, and the lighting up of the fires again, which led to some of the more serious accidents in the ships by breaking the headers. That being the case, it is a question whether a boiler with a bent tube is as bad a thing as seems to be made out. Some of them have been in use for a very long time now. In the case of the British gunboat *Speedy*, I

saw the boilers of that boat this summer and they had been in use pretty constantly for six years. A set of the tubes were taken out (these boilers were used under forced draught, a pretty high forced draught, most of the time), and the tubes were cut through the middle. Now those boilers were built as torpedo boat boilers were formerly built, with very thin tubes, and they were really good enough to have gone on for another commission. But with that class of boiler, for a large ship, they would now put in very much thicker tubes. The tubes being bent the expansion and contraction are taken care of and that also removes one of the difficulties set forth as being a disadvantage with the water-tube boiler—namely, that the units are too small. Now with a large tube boiler as at present designed—any one of them, I don't care which it is—you cannot get a big unit for a war vessel. Take some of the recent battleships building—twenty-four to thirty boilers, having 16,000 or 18,000 horse power. With the large bent tube type of boiler, two of the battleships are being built with only twelve units, and that is possible and it is only possible under those conditions."

F. L. DuBosque spoke of the water-tube boiler applied to ferryboat service: "The old system of propelling ferryboats with low pressure steam was to provide boilers that were practically a little more than half of the full power required of the engines. Ferryboats ususally lie in the slip nearly as long as they run, and with a boiler of this capacity enough steam is generated to carry the boat across the river, and the pressure falls. When the boat lies in the slip the pressure rises and enough steam is generated to carry it back again. The great advantage of high pressure steam for propulsion brought forward its adoption on ferryboats, and at once it was seen that the old system of stored energy could not be followed. It is practical, to a large extent, on boats that lie in the slip nearly as long as they steam. But in the case of ferryboats of high speed that are in operation, say, 75 per cent of the time, and lie idle in the slip 25 per cent of the time, an entirely different problem is before us. In vessels of this type we believe it is practically impossible to use high pressure cylindrical boilers. If the service calls for 2,000 horse power to be generated during all the time that the boat is running, it is impossible with a shell boiler to shut off the generation of the 2,000 horse power while the boat is lying in the slip. You can also see that for a boat that is running 75 per cent of its time, in the other 25 per cent it is impossible to store enough energy to enable her to complete the trip. Therefore the water-tube boiler seems to be a very proper thing in such service. Those boilers have been used on some of the ferryboats in the harbor here for the past three years, and the theory has been carried out very nicely. The boats were able to maintain (where the boilers are large enough) the full power and pressure for 75 per cent of the time. For the other 25 per cent, when they lie in the slip, because of their flexibility and the easy control of the firing, the drafts can be closed, and the boiler practically supplies only enough steam to run the auxiliaries. One principal reason, I should have stated first, for having these boilers is to avoid blowing off steam. It might be said that steam could be blown off either into the condenser or into the atmosphere—we all realize that that would be a waste of heat. On the ferryboats that have water-tube boilers, we have come to the conclusion that there is a saving of from 15 to 18 per cent in fuel by their use."

W. D. Forbes said in his experience the water-tube boiler wears out exactly like the "one-horse shay." It all goes to pieces in a few minutes, but is very easy to repair. The expanding of tubes can now be readily carried out. He had found, however, that in rolling the small tubes in these boilers, so as to get them tight and have them remain tight, it was impossible to do so very quickly. It seemed to demand time for the metal to flow. Expanding a tube with a speed of rotation of, say, twenty or thirty turns a minute would momentarily tighten the tube, but the slightest subsequent strain would start a leak. He was surprised at the lack of provision for keeping the outside of the tubes clean, other than a little door and a nice apparatus on the end of a hose to blow out the dirt. This was not effective, and it would be easy to introduce a system in which, by simply turning valves, the dirt would be blown from the top drums and all parts of the tubes down to the bottom of the lower drums into a suitable receptacle. In repairing boilers used during the Spanish war he had found that from the lower drum up as high as he could reach they were "absolutely solid with dirt." The interior of the tubes, on the contrary, were spotlessly clean and there was nothing to show that there was any danger from stoppage, though this had been feared. The outsides of the tubes were pitted and eaten up for lack of any provision for cleaning. In reply to a remark of Mr. Dickie, the speaker said: "I believe there is a vast difference between the steering of a boat with cylindrical boilers and one with water-tube boilers. At the end of the first ten minutes one would have no use for steering, as she would lie idle, while the other would be under way and would naturally have to be steered."

Mr. See said the principle on which the water-tube boiler was founded was sound. The elements entering into the construction of the cylindrical boiler were more numerous and more dangerous than those entering into the construction of the water-tube boiler. The tube existed in the former as well as the latter, and was subject to the same causes that produced decay and injury. In addition there were furnaces liable to collapse, a combustion chamber subject to eating away and leakage at the joints, and the large shell subject to injury at the joints, and also from unequal expansion and contraction of its thick plates. He believed that in the water-tube boiler, unless the tubes were submerged, or arranged to let the water come in close contact with all the parts subjected to hot gases, they would suffer more rapid deterioration or become loosened at the ends. As to the bulging of the drums of the *Nashville's* water-tube boilers, this should not be charged to the type, for this had happened to all boilers where the gases were allowed to come in contact with the metal, where only steam and hot water were against the other side. The boiler with straight submerged tubes and no steam space exposed to the gases possessed greater advantages than those enumerated by the author.

Mr. McFarland, in responding for the author at the close of the discussion, referred to the statement of

Mr. Woodward regarding the fresh water supply. He did not know that an adequate supply of fresh water was more needed in the case of the water tube boiler than with the cylindrical boiler. It was a fact that the necessity for such reserve supply had been recognized, though in the past no such special provision had been made. If, however, an adequate make-up arrangement with a small reserve space was fitted, it probably would amount to the same thing in both cases. He was sure Admiral Melville would be very much pleased with the discussion that the paper had brought out.

SUGGESTIONS AS TO IMPROVED APPLIANCES FOR LAUNCHING SHIPS' BOATS.

BY JOHN HYSLOP.

In introducing his subject the author makes this statement: "It yet remains that the vast development of ocean travel in the past half century and the increased water traffic of every kind has been unattended, except in rare instances, by any change whatever in the method of launching ships' boats." As causes for this remarkable situation he gives: "Lack of technical knowledge on the part of those with whom has rested the adoption of new propositions, and a consequent want of confidence in any estimate they ought to make of the value of such propositions, or of the possibility of effecting any amendment;" also remoteness of marine disasters from public observation, and in many instances total disappearances of vessel and crew. The author was one of the survivors of the *Mohegan* disaster, which occurred on the night of October 14, 1898, and resulted in the loss of many lives. To this he probably refers, though not by name, in these words: "It was most distressing to see 150 men, women and children waiting through ten or fifteen minutes, each elapsed minute narrowing the limit of life for over two-thirds of that number, only one boat being got clear of the ship, and that one in a damaged condition." Boats have been put afloat from a ship's deck within three minutes from the time the order was given, under the most favorable conditions: In daylight, ship neither rolling nor listed, boat handled exclusively by sailors. On one of the largest transatlantic steamers, however, which was well equipped with boats in the usual way, the question was asked: "What could you do if the vessel was rolling or listed?" and the reply of one of the officers was: "We know we could not launch them at all." Ordinary davits and heavy boats could not be swung out in heavy weather, nor when a vessel is listed. From experience and actual occurrence the author knew that such attempts were attended with loss of life or limb. "It appears both interesting and instructive," he continued, "to inquire how far it is practicable to carry ships' boats inside the lines of a ship's sides, and yet at all times outside the davits, and also to inquire if any better means can be used to operate and control the present common form of davit." Reference is then made to the Mallory davit patented in 1871-73. In this form the davits are hinged at the lower end and the boats, though inboard, are carried outside the davits. An angle iron frame extends in an inverted L outward from the top of the deckhouse to the beam ends, and then downward to the ship's side. On top of this frame the boat is carried in chocks, and when raised from its seat the davits falling outward carry the boat clear of the ship's side, their outward movement being controlled by falls to the extreme outboard position, which is fixed by the frame referred to. The davits are of rectangular cross section. An objection to this form is the necessity for stretching a tackle from each davit across the deck to regulate its outboard movement. The author proposes a more compact and permanent winch arrangement which would be always ready for operation, and with which, by turning a crank handle, the boat would be raised from its seat and the davits moved in an outboard direction at one and the same time. Reference is also made to the device patented by Sir Bradford Leslie, of Falmouth, England, which provides a cradle for carrying the boat inboard, the cradle being supported on top of a long arm or davit which is carried down outside the ship's side and hinged above the water line. To operate this device the davits are lowered vertically, the hinged end working in a slide, until the boat is brought down to a convenient height to load from the deck, then the davits are allowed to fall gradually outward, the boat traveling through an arc of a circle, and when the water level is reached the boat floats off. The outward movement of the davits is supposed to be controlled by a wire rope wound around a drum on the deck and suitably braked. Details which in the opinion of the author demand attention are: Wooden vs. metal boats; cork fenders; chocks and releasing tackle; gripes and davit guys; detaching hooks. The location of the boats with respect to the rail, and methods for covering and securing boats so that they may be readily prepared for launching, also the control of davit movement by worm gear, are discussed. In conclusion the author states that if no advance over present methods is made, he would, from past experiences, prefer to depend on swimming or on a floating hatch, spar or plank for safety, rather than upon the likelihood of getting boats properly afloat in a short period of time.

Upon reading the paper the author exhibited a small model of his proposed system and pointed out that it would hold the davits and boat at any particular point in their outboard movement. With the ordinary methods it was very difficult to control the movements of the boat when the vessel was rolling. The boat was usually very heavy and there were but few men to get it out. On a liner, while eight or ten men would probably be assigned to each boat, the number would not include more than two sailers, the others would be from the steward's and engineer's departments. In a case in his experience in lowering a boat with ordinary appliances one man was seriously injured and another crushed to death, between the boat and the rail, when the boat swung in.

DISCUSSION.

JAMES R. RAYMOND, in a communication, called attention to the great power and consequent responsibility placed by law in the United States Board of Supervising Inspectors of Steam Vessels in the matter of providing life-saving appliances on passenger steamers. After referring to the Federal laws governing the case, he adds:

"The law entrusts this board with the selection and

enforcement of such measures as will best secure the safety of persons traveling by water; and it also, in terms positive, instructs how it shall be done. The Board of Supervising Inspectors should, therefore, be eager to determine the best appliances for the purpose and enforce their use without fear or favor. But it is plain to anyone familiar with the proceedings of the Board relative to detaching apparatus that they have aimed to do as little as possible, and have shown no disposition whatever to comply with the law, and in so doing, inferentially at least, serve the pecuniary interests of the steam vessel owners, rather than those whose lives depend upon the selection of the best means extant for the preservation of human life on shipboard. In substantiation of this it is only necessary to consider the number of passenger steamers provided with no detaching apparatus whatever other than the antiquated hook and ring, which cannot be considered to be a detaching apparatus in compliance with the specific requirements of the law; and to consider the further fact that some detaching devices which the board, according to the record of their proceedings, have condemned as death traps and whose only recommendation is their cheapness, are allowed to remain in use, to have their defects discovered only in time of disaster.

"The Supervising Inspector-General has asked that the statutes be amended so that the Board might be enabled to select a proper device, claiming as a reason that, according to the wording of the statutes, they are prevented from giving their approval of any device other than the one mentioned therein, namely, the one operated by one person, disengaging both ends of the boat simultaneously, etc., etc. Had he the welfare of the public at heart would he, or the Board of Inspectors under him, find anything in the language of the statutes that would forbid the selection of any good device, the universal use of which would familiarize all sailors with its operation? Would not the enforced use of a good device, so selected, prevent the terrible blunders and loss of life now so often occurring in emergencies, because of the use of a multiplicity of defective devices?"

He closed with a plea for a thorough examination by a competent body of men into the whole subject of launching ships' boats.

Secretary Francis T. Bowles said the paper just read had been prepared in response to a public request from the Society for contributions relating to the subject of saving life at sea, and he expressed to Mr. Hyslop the pleasure and gratitude of the members which the reading of the paper occasioned, and for the suggestions which it contained.

Second Technical Session.

Rear-Admiral Bunce, U.S.N., again occupied the chair when the meeting was called to order at 2.45 o'clock on Thursday afternoon. He announced the continuation of the discussion on the paper read by Mr. Hyslop.

William P. Stephens spoke of the importance of the paper, referring briefly to the recent loss of the *Charleston* and the burning of the *Patria*. He suggested the appointment by a committee to proceed with the investigation of the subject.

Captain Randall, in discussion, said: It has been my good fortune to have been in command of transatlantic liners for the last twenty-five or thirty years. During that time I have witnessed many serious mishaps occasioned by the lack of a speedy device for detaching boats from the sides of ships. The last serious mishap that I observed was when, in command of the *St. Louis*, I was able to save 243 lives from the *Veendam* of the Netherlands line. It was on a dark night and in a stormy sea. We succeeded in lowering four of our life-boats and finally, in three hours, we rescued those people. Fortunately our appliances were very good. But in the work of rescue we smashed in two or three of our boats from the sudden rolling of the ship. After we had swung them out they then rapidly came in before we could lower them down, and smashed the whole side in. It brought very prominently to my notice that we were at fault in having ships' boats hanging to davits at all. Some other method should be applied or invented whereby we could readily detach the boat from the ship, and the idea has occurred to me many times that a boat kept in a depressing cradle athwartships of the ship, that could be readily launched end on overboard, would be the most feasible method of launching a boat from a ship. It requires neither davits nor tackles nor detaching apparatus. It could be placed on an athwartship cradle on a kind of launching way; and by depressing the cradle on whichever side you wished to launch the boat it could be readily slipped overboard. It would make no difference whether the ship had five degrees of list, or twenty or more, or even up to an angle of forty degrees. Supposing that a ship in collision had water suddenly brought in on the one side or the other, the boats on one side of the ship, under the present method, are entirely useless, whilst the other side is very often almost in the water, as was the case with the *Elbe* when she was sunk by collision in the North Sea, and many others I could cite.

"Ships' boats should be of greater capacity than now; they should be double bottom boats. They should be also rounded at each end so that they could be launched readily overboard, and it is surprising how little water will go into a boat when it is launched end on overboard; I have tried it many times myself. I saw a boat launched once in that way when the ship was going at the rate of ten knots and not more than a hogshead of water got into that boat and she readily cleared herself by having this double bottom and movable plugs in the bottom of the boat. I saw the boat launched repeatedly under those circumstances, and she was off and afloat, and by a long painter was brought alongside of the ship—that boat had a capacity of a hundred persons."

The speaker favored further action by the society.

Francis T. Bowles said that rather curiously the same idea of launching boats had occurred to him, but he had refrained from proposing it, as it had seemed to him so unseamanlike. Now, however, that the suggestion had come from Captain Randall, whose experience had been very great, indeed, he believed that it ought to be developed and carried out. Boats should be stowed athwartships instead of fore and aft as now, and they should be made of larger capacity. It was well known that boats were more seaworthy in proportion to their size. A simple means of launching should

also be provided—a method somewhat similar to "shooting the chutes."

JOHN HYSLOP, in responding, reported a recent conversation he had had with a chief officer of a transatlantic liner, who, in reference to the matter of boats, said: "If I had my way we would not have more than four boats," and in explanation, continued, "we could never launch them; everything would be confusion. They are a bother. They are in the way. My opinion is that the safest thing in the case of a calamity would be for a person to keep quiet, and the person who kept the quietest and who was in the least bit of a hurry would have the best chance—on a plank or something of that sort." Continuing, the speaker said that no matter what care and forethought were exercised, accidents would happen to vessels which human ingenuity could not foresee. He referred in brief to the recent collision between the *City of Rome* and an iceberg, and the danger from striking ocean derelicts. A good, stout ship's boat once properly afloat would weather any storm and he instanced the case of the S.S. *London*, where an officer and several men were put afloat in a boat during a severe storm in the Bay of Biscay. The captain gave them the course and they reached land in safety, while the vessel went down. He urged that the Society appoint a committee out of its membership to consider the question.

NAVAL CONSTRUCTOR W. L. CAPPS said the appointment of a committee presented many obstacles. There were many subjects of great importance to be considered, and he believed the question of a committee should be referred to the Executive Committee with power to act. They could either act as a committee or appoint a special committee to consider the matter. He called attention to the "most effective incentive to development of this kind" which had been offered by the heirs of the late Anthony Pollock, of Washington. Through the French Government they offered a prize of, he believed, 100,000 francs for the best plan of saving life at sea. Without doubt within a year there would be a multitude of suggestions, many of them good, to that end. He moved that the matter be referred.

E. PLATT STRATTON told of the landing of surf boats in high seas, which was accomplished in safety owing to the skill of the crew. One difficulty in launching boats was want of skill in the boat after she struck the water. The best disengaging apparatus that he knew of was that which automatically disengaged both ends of the boat at the same time—and this could be done while a vessel was moving at speed. He suggested that each ship carry a certain number of skilled surfmen who would act as captains of the boats.

W. P. STEPHENS seconded Mr. Capp's motion and it was put by the chair and carried.

ELECTRIC PLANTS OF THE BATTLESHIPS KEARSARGE AND KENTUCKY.

BY NAVAL CONSTRUCTOR J. J. WOODWARD, U. S. N.

This is a paper descriptive of the most extensive installation of electric auxiliary machinery yet attempted on any vessels of the United States navy. Tests and the resulting record of efficiencies are not included, as the installation of the apparatus was only partially completed at the time the paper was written, but the author expresses the hope of making a further and later contribution to the Society dealing with these matters. The installation on these battleships covers the range of auxiliaries for the general service of the vessels, with the exceptions of windlass and steering gear, and does not extend to the engine room auxiliaries. Thus the author comments that these plants can only be regarded as an intermediate step between the complete steam drive for auxiliary machinery and the complete electric drive for all auxiliary machinery in the ship—"whose adoption appears to be a possibility of the future." The most serious limitation to the extension of the electric drive is the time necessary for the officers to instruct the members of the crews who would be intrusted with the immediate care and manipulation of the electric apparatus. While the installations on the two ships represent a concentration of electrical devices, yet these, in a cruder form, have been in operation separately on many ships of the navy —among such come turret turning gear, ammunition hoists, blowers, etc. The satisfactory working of these minor installations, even in action, is referred to as an answer to expressed doubts whether the systems on the two new ships can be maintained in a constant state of high efficiency. Brief reference is made to the electric equipment of the Russian warships building here, in these ships electricity being substituted for steam as motive power for all auxiliaries both in the engine room and above decks, with the result that large and economical units are employed in the generating plant. Work to be performed on the *Kearsarge* and *Kentucky* by the electric plants includes: Ship lighting; search lights; signal sets for working the ship and for distant communication; running lights and lanterns; turret equipment; turning, hoisting, gun working, ventilating gear; independent ammunition hoists; deck winches; boat cranes; ship ventilation; in connection with steam steering gear. The method of distribution is the Edison three-wire system, allowing the use of two pressures—80 and 160 volts. The ship wiring can be so connected as to operate any motor on the ordinary two-wire system at a reduction of one-half its capacity. The generating plant is located below the protective deck, between the inner wing bulkheads, and is disposed in three sections. On a platform three dynamos are carried and below this there are two compartments divided by the center line bulkhead, in each of which there are two dynamos—seven in all. These machines are six-pole, fifty-kilowatt, eighty-volt, compound wound dynamos, each driven by a direct connected, vertical, tandem compound, single crank, engine running 310 R.P.M., with 100 lbs. steam pressure and 25 in. vacuum. The lowest pressure at which the engine will carry the full load is 80 lb. and 25 in., and it will carry an overload of 50 per cent if need be, also being capable of operation with steam up to 150 lb. pressure. The cylinders are 10 1-2 in. and 18 in. by 8 in. stroke. Two balanced piston valves and fly-wheel governor are fitted. Very complete oiling devices are supplied and the engine is completely enclosed so that no splashing is possible. Each generator has, supported from the upper frame, a connection head board provided with suitable switches and circuit

breaker, from which all cables and field and pressure wires are led. The main generator switch board is located on the platform in the dynamo room and consists of seven slate panels, containing an ammeter, switches, and a rheostat for each generator, and one instrument panel, with volt meters, ground detectors and lighting switch for the dynamo room circuit. From the switch board busbars feeders run to three separate distribution boards which are situated on the splinter deck, one forward, one amidships and one aft. These in turn are connected with seven auxiliary distribution boards used for power purposes only, which give convenient centers of distribution and reduce the number of wires that would be required if each motor were fed individually from the main distribution boards. The paper gives a detailed account of the scheme of current sub-division to perform the numerous functions of lighting and power, and also a general description of the controlling appliances and the mechanical application of the electrical energy to accomplish the desired results. Many valuable plans, detailed drawings and engravings accompany the paper.

DISCUSSION.

CHARLES J. DOUGHERTY said: "The three-wire system is new in our navy and it gives two pressures and also allows a saving in copper, but this must be balanced against the simplicity which is in the two-wire system. In the three-wire system it seems to be acknowledged that there is more complication than in the present two-wire system. In other words we must educate our men in the navy to take care of the complications required by the three-wire system, acknowledged to be more complicated than the two-wire system.

"Another thing, which is very interesting, is that the ships which foreign powers are having built in this country are being equipped more completely, electrically, than those of our navy, and it becomes necessary for the engineer charged with the duty of selecting a system to weigh carefully the advantage of one system as against the other. Consequently he should look at the other side as well as the good side, which is always pushed forward. First of all, balancing of the three-wire system is almost always necessary. Unless great care is taken the lamps on one side will be higher in voltage than on the other and there would be winking.

"In regard to the concentration of circuits on the *Kearsarge* and *Kentucky*, we find that distributing panels have been located in the forward and after part of the boat, and consequently the circuits are much smaller; the number of bulkheads pierced is less and it is a very good idea, I think.

"As I said before, the three-wire system is more complicated. Another thing about the three-wire system is that there are grounds and when grounds occur on a three-wire system it is impossible to locate them, and the insulation capacity of the plant is reduced, because the potential is now 160 where it used to be 80. This is something we should look into. It is acknowledged to be more difficult to insulate at 160 than at 80. I think we should first see how the plants of the *Kearsarge* and the *Kentucky* are working, for a year or so, before we draw conclusions whether the system is a perfect system or whether the system should be considered in further installations. When you consider that, as I said, foreign powers are having vessels built in this country, and electric plants are increasing all the time, we should look for a better system, and if the three-wire system is the best system to install, I say by all means introduce it on board every ship that we have in the navy."

CAPTAIN RANDLE said that in 1883 he was at Laird's yard in Birkenhead superintending the construction of two ships for the Red Star Line. At that time electricity was not much used on vessels, only one ship, the *City of Berlin*, having a very primitive lighting plant. It was decided to install electric lighting plants in the two new ships and the machines were provided by Siemens of London. In one ship there were 400 incandescent lamps, and in the other 300 lamps. In both vessels both generators were put in the most convenient places without regard to their working conditions. That in the *Westernland* was placed on a platform in the forward part of the engine room just above the cylinders—the hottest place in the ship. The lights on the *Westernland* proved to be very inefficient. On the *Noordland*, however, the dynamos were placed in the after part of the engine room, and they ran cool and pleasantly and the lighting was most satisfactory. Explaining this he said the direction of the currents of air through a ship while in motion was a matter not generally understood. Ships are fitted out in shipyards while lying still, and it is not generally known by experts in shipyards that a current of air below decks is in the reverse direction to that in which the ship is traveling. "When it is blowing a gale of wind and the ship is going ahead, the current of air below decks is directly toward the bow, and therefore all heated currents, no matter where they originate in a ship, are flowing towards the forward bulkhead." This explained the poor working of the plant on the *Westernland* where the dynamo located at the forward end of the engine room received all the heated air, while in the *Noordland*, with the conditions exactly reversed, the plant worked perfectly. With regard to the *Kentucky* and *Kearsarge*, he considered the location of the dynamos near the boilers faulty and suggested that the electric plant should be placed as far from the engines and boilers as possible. In any given compartment dynamos should be placed against the after bulkhead, so that the heated air would flow away from them.

S. DANA GREEN referred to the paper as "the most complete and comprehensive of the kind ever prepared," and further said: "I think the author is to be congratulated upon having given such great care to the minor details of construction of the various motors and their mechanical application to the auxiliaries of the *Kearsarge* and *Kentucky;* because I am thoroughly in accord with him in believing that a great deal of the success of the operation of the auxiliaries in practice depends on these details.

"The question presented by this paper really brings up a much broader one than the mere application of these auxiliaries on board the *Kearsarge* and *Kentucky*, because it is the beginning of a step which, if carried out to its logical conclusion will mean the electric drive

for all auxiliaries on board ship. It is a subject that I have been interested in for a number of years and to which I have given considerable thought and study, both on account of my former connection with the Navy and on account of my active connection at the present time with electric work. Its success, and therefore its ultimate adoption in the service, must depend on the results which are obtained in practice in the service in the *Kearsarge* and *Kentucky*, because those are the first two ships of our service where the system has been employed to any great extent.

"There are two main features to be considered, it seems to me. One is the question of reliability, and the other, ease of manipulation. If the apparatus is not reliable and is so delicate that it cannot be handled by the class of men on board ship, no matter what its economy, whether estimated or actual, may prove to be, it is going to be thrown out—it ought to be thrown out. And if it is uneconomical, so that the coal endurance of the ship is reduced or her steaming capacity reduced, it should also be thrown out. I firmly believe that the electric drive will prove its superiority in both of these respects.

"I think that Mr. Woodward is right in saying that one handicap which the navy is under at the present time, is the lack of sufficient officers and men who have enough practical knowledge of the electrical apparatus to handle these various appliances on a ship to-day. But I think the same thing may be said about a great many things that go on board ship to-day; we have not got men enough who are familiar with the latest appliances, and I think the men ought to be taught about those appliances. The Government should provide schools for that purpose, just as schools are provided on shore for instruction in other branches, if the Government is going into the electric drive. I am not sure that that is an objection that can be considered a permanent one. It may be an inconvenience at the present time.

"So far as reliability is concerned I am equally sure from the experience that we have already had on board ship and from the operation of electric motors in such service, for instance, as street car service on shore, that the motors that have been put on board the *Kearsarge* will stand the test of service.

"There is another advantage, of course, in the electric drive with reference to the circuits running about the ship, which to my mind has a decided importance from a military standpoint, and that is the question of wires versus pipes. We all know how demoralizing the bursting of a steam pipe is, either in time of peace or in time of war, under high pressure, and it seems to me exceedingly likely that in a severe engagement, especially of unarmored ships, one or more of the steam-pipes, or circuits, whatever they may be, whether wires or pipes, are liable to be hit. Of course, if a wire is broken by a shell it may disable an auxiliary just as the breaking of a steampipe would; but the damage will end there, and it is easier to repair, as well as being harder to hit in the first place.

"On the question of economy, in a paper which I read before the American Institute of Electrical Engineers last winter, I made the statement that taking the most modern electrical apparatus and the most modern steam apparatus, the economy of steam consumption at the auxiliary was about as two to one in favor of the electrical apparatus. That is to say, there are makers of electrical apparatus to-day prepared to guarantee 40 lb. of water per indicated brake horse power at the auxiliary. Many present are familiar with the result obtained from a series of tests on the *Minneapolis*. We tested her auxiliaries on a cruise from Gibraltar to Philadelphia, two or three years ago, where the main engine economy was shown to be 20 lb. of water per indicated horse power and the auxiliary 119 lb. of water. That test, I think, was one of the things which drew the attention of everybody in the Navy Department to the necessity of greater economy in the steam auxiliaries, and there is no question but what the consumption can be very much reduced. I very much doubt, however, whether it will ever be got below 75 or 80 lb. of water per indicated horse power at the auxiliary.

"As Mr. Woodward points out in his paper, the larger the installation of electric motors, and therefore of generating capacity on board ship, the larger the generators will be, the larger the engines, and therefore the greater economy possible in the main generating plant.

"As to the increase of weight on board ship, that is an important consideration. The electric drive will weigh, all told, between two and a half to three times as much as the steam drive. That, however, is with the present form of steam engine and electric dynamo, such as has been described in this paper. But even with that, I showed in my paper that the saving in economy, and therefore the saving in coal space required, is considerably more than the extra weight added by the additional plant.

"Furthermore, I am firmly convinced that the time is not far off when we shall have a commercial steam turbine which will run, of course, at high speed. For instance, the units on board the *Kearsarge* are 50 kilowatts. The speed there is 40 revolutions per minute. The 50 kilowatt steam turbine will probably run at 600 revolutions and the weight and size of the turbine and generator will be reduced something over half the present steam plant. Vibration will be practically eliminated, that is, the vibration due to reciprocating parts. That means less foundation work, less bracing for foundations, and the application of the steam turbine on board ship for that class of work is almost an ideal one. Doubtless you are all more or less familiar with the experiments with the Parsons turbine in England for driving the propellers on torpedo boats. But there are other forms of turbines, some of which are being developed in this country, and while it has not yet been developed in its final, commercial form, the experiments thus far made I think are sufficient to justify the belief that it will be developed as a commercial success in the near future."

George W. Dickie agreed with the former speaker as to the value of the paper, which dealt with things in a formative condition.

"The electric installations on our warships have not yet crystallized themselves into anything that might be called adopted standards. I have had considerable experience in regard to this," he said, "because every

little while, from the Bureau of Equipment, there comes out a set of standard blue prints, and in a little while another set of blue prints comes out that is also standard. A year ago we got a standard box and I figured out how many junction boxes we would need for the ships we had under way, and I put in the ship 3,000 junction boxes in accordance with this standard. I think about two months ago we got another standard junction box, and we had made 2,800 of the old standard. So I had to get down on my knees to the Bureau to use the old standard for a little while until we worked out the 3,000. I think the new standard is considerably lighter. I lost 4 1-2 lb., I think, in each box, so that this simply illustrates what we are doing in electric matters.

"I am glad that some of the remarks made by Mr. Woodward are not in this paper. For instance, he suggests that enclosed motors should be tested with a salt water hose on them. I hope that does not become standard, because it is sometimes awkward to do that sort of thing. The other day an inspector suggested that an enclosed dynamo should be lowered down ten feet under water and remain there twelve hours and then be run for six hours thereafter. That was worse. (Laughter.) It has not been done. But if you remember, in 1893, I advocated a single system of some kind for power transmission on board ship. I then advocated a hydraulic system of power transmission and proposed to operate rotating machinery by water turbines. Since then, things have changed and the electrical transmission seems to be the coming transmission on board ship. In a paper I had read two years ago before the Society of Mechanical Engineers in this room, I went over the advantages and disadvantages of the various types of transmission on board ship and then intimated that I thought that we were drifting into electric transmission. But whatever goes on board ship I still maintain that one method of transmitting power should be adopted. If an electric motor can be relied on to work a boat crane it can be relied on to work a winch; it can also be relied on for a steering gear and for a windlass. I have just sent in to the Construction Department an electric windlass for one of the ships. I firmly believe that we have come to the time when we can say that no steampipe should be carried outside of the engine and boiler room enclosures except in the dynamo room, wherever that is placed, whether it is forward of the heated compartments or aft, as one of the speakers has stated it should be. I believe that within the next six or eight months we will probably be able to talk more definitely in regard to this subject.

"On the *Wisconsin*, as probably a number here present are aware, we have adopted a somewhat different method of control for the turrets than that described in this paper. We abandoned the one gear for operating the turrets, operate each side as entirely independent of the other and control by hydraulic gear. It will be interesting to find out, which we will do very soon, as to the advantages of this compared with the method of control adopted on the *Kearsarge* and *Kentucky*. The advantage of adopting a control outside of the generator and wire system is that it is not necessary in that case to run special generators for the purpose of operating these turrets, which must be done with the method of control adopted on the *Kearsarge* and *Kentucky*. I think that that will be important, especially when going to quarters and operating these turrets, as they must be operated daily, in order to keep them in good condition.

"There are a great many points in this paper that one could talk about if one had the knowledge to do so. In fact, the paper enters into subjects for which we have very little data as yet to direct us as to what we should do. I think that the time may come when we can operate generators by direct steam turbines as has been suggested; but that time has not come just yet.

"We have been making balance engines that have given very good satisfaction, and in regard to economy I might state here that the generating sets for the *Wisconsin* on twelve hour tests gave the kilowatt output for 31.8 pounds of water in the form of steam consumed, which goes to show that there are great possibilities in regard to economy. However, comparisons have been made in regard to economy of an electric system where the prime movers in the electric device were much more economical engines than those that they were compared with. Making all auxiliaries simple engines of the most wasteful kind I think has done a great deal to bring about other systems of power transmission on board ship. I have invariably advocated the most economical engines for auxiliary purposes because they run oftener and, perhaps, burn more coal in the aggregate than the main engines of the ship. We have two battleships that we have been noting lately where the daily consumption for auxiliaries in one case was 8 1-2 tons and in another case, a similar ship with the same number of auxiliaries, 17 tons. So that the kind of auxiliary is a very important factor to take into account when comparing systems of operation. Apart from the system of operation I think that the steam pipes, outside of the engine and boiler room enclosure, are something that should be avoided as far as possible. They generate heat and the continual heating and cooling of them causes trouble with the joints. Perhaps there is more trouble with leaky joints with steam pipes, outside the engine and boiler room enclosure, than there is with the main pipe inside. I think that any engineer who has been at sea would bear me out in that statement."

F. L. DuBosque believed that the reference to economy made by Mr. Greene in discussion was open to criticism. If the economy predicted by that member could be accomplished no doubt all auxiliaries in vessels would be driven by electricity. It could be readily conceived that a fan driven by electricity would be very economical, as the fan would only take the power in proportion to the air expelled. But could a circulating pump, for example, be so successfully driven electrically? It had been his belief that the electric motors would have to be run at constant speed, and to throttle this by the use of rheostats would be very wasteful. He quoted some of the figures already discussed and calculated that by the use of the electric drive and the interposition of rheostats he would get a consumption of 80 lb. of water per horse power at the auxiliary.

S. Dana Green said the speaker had apparently mis-

understood some of the power statements, and went on to show that the figure given by Mr. Dickie—31.8 lb. of water per kilowatt at the generator—would, after allowing for line and motor losses, give a consumption of 40 lb. per I.H.P. at the auxiliary. The rate of 75 to 80 lb. per I.H.P. for steam auxiliaries was understood by the speaker to apply to the most improved form of compound engines, working under the maker's guarantee. As to the ability of electric motors to operate efficiently at different speeds he referred to the electric street and L-road cars, in which cases the speeds ranged from zero to 40 miles an hour. There were many ways of regulating the speed of an electric motor aside from the wasteful method of introducing dead resistance—by suitably winding the motor.

Naval Constructor J. J. Woodward, in responding, said the importance of the proper instruction of the personnel in the use of electrical apparatus, whether three or two-wire systems were adopted, was recognized. In the case of the *Kentucky* and *Kearsarge*, voluminous instructions had been prepared for the use of the officers and men. As to the distribution boards located in different parts of the ship, these boards were adopted through force of circumstances—to avoid carrying back all circuits to the dynamo room and the consequent multiplication and complication of wires, etc. There was really nothing novel in their adoption so far as the transmission of power was concerned. As to the equipment of the foreign ships with electrical apparatus the speaker believed that had the plants on the *Kearsarge* and *Kentucky* been advanced to their present stage of completion when those installations had been begun the foreign officials would have recognized the advantages in the reduction of the amount of wiring. Answering the criticism of Captain Randle, he said the protection of the electric plant by armor had to be considered. In the case of the *Kentucky* and *Kearsarge*, the solution was not ideal, but the conditions of habitability in the dynamo room were excellent. Fans capable of handling the entire volume of air in the dynamo room in every forty-five seconds had been provided, and where the fan capacity was properly proportioned the variable currents of air referred to had less influence, probably, than where natural ventilation was relied upon. He recalled a remark of a French naval constructor made during his student days abroad, who told him to always mark his plans with red arrows to show where the air supply went and blue arrows to show where the exhaust came from, and to remember that in practice the air would not go that way at all. He was unable to reply to questions regarding efficiency as no tests had yet been made. The matter of "external details" was extremely important—making the various parts that require to be moved in service sufficiently robust to stand the severe conditions of ship work. Apparatus that might look amply big and strong in the shops had a fashion of shrinking up wonderfully when placed in an exposed position on the ship. There seemed also to be a marked tendency for all small iron and steel parts to rust where one might suppose this would not occur.

INCREASING COMPLICATIONS IN WARSHIPS AND HOW SIMPLER ARRANGEMENTS MIGHT BE ADOPTED.

BY GEORGE W. DICKIE.

This paper is a strong plea for the simplification of the interior fittings and equipment of the modern warship, the present tendency being in quite the contrary direction. In opening, the author states, that "the increasing complication and multiplying diversity of functions sought to be reached by mechanical contrivances has become a positive dread to the officer who is held responsible for it all operating in the proper way." The author attributes the complications to two causes: Uncontrolled growth of new devices, additional to existing devices, causing multiplication of apparatus "for doing one thing," and the divided system of control, making a homogeneous design and the proper consideration of the interrelation of functions impossible. As a step towards simplification the author proposes the construction of a tunnel or passage, extending from the chain lockers forward to the steering room aft, to be located on the center line of the ship immediately under the protective deck. This would be the "spinal cord" of the ship, and from this he proposes to "deliver to every compartment of the ship that needed it, by lateral branches only, light, heat, power for auxiliaries, air, and orders of every description." This idea is treated as to its main features only and in relation to the battleship as distinguished from smaller vessels. The passage would be 4 ft. wide and 11 ft. high, the floor making the horizontal stiffening necessary for the center line bulkhead, which would be of the usual construction and extend from the inner bottom to the floor of the proposed passage. Referring to a cross (fire room) section through the battleship *Ohio*, accompanying the paper, which shows the proposed passage in place between two cylindrical return-tube boilers, the author presents some arguments in favor of the fire-tube as against the water-tube boiler. These do not, however, refer to the installation of one type or the other from a structural point of view, but from that of operation. Returning to the subject of the paper, extended references are made to the existing drainage and fire service systems on board our warships. The former he traces from the hand pump of early times, through the period of engine driven bilge pumps, to the method of independent pumps of to-day, none of which took the place of the preceding system, but rather added to the growing complication. Nowadays numerous compartments in the double bottom and elsewhere, coupled with the manifold system in use, occasioned a perfect network of piping—forty-seven drainage pipes were recently counted in the forward end of the engine room of a battleship. The author proposes to abolish all hand pumps, manifolds, emergency connections, combined bilge and fire pumps and such. For these he would substitute two main drainage pipes running the length of the ship, one on each side of the center line bulkhead and just above the stiffener brackets. All suction connections would be made direct to these pipes, and the main pipes so connected that either could take care of the entire drainage of the ship. The controlling valves would have stems passing up into the central working passage,

where would also be fitted sets of vertical single-lift jack-head pumps operated by gearing, the power being in the form of 10 horse power electric motors. The discharges would, preferably, pass up through the berth deck and then overboard above the water line. The pumps would be 12 in. dia., 24 in. stroke, three to a set, and six sets in all—total capacity of system 1,500 tons per hour. One set of pumps would be kept in motion continuously to produce a vacuum in the drainage pipes. The author next pays his respects to the fire service as now installed and proposes, instead, that two large salt water compound pumps be fitted in the pump room between the engine and boiler room. One pump would be always in operation, furnishing pressure for engine room service, distillers, coolers in ice machines, sanitary purposes, flooding magazines, and for washing decks. In case of fire the pump would be run high pressure in both cylinders and would maintain a water pressure of 120 lb. in the mains. There would be two mains running the entire length inside the central passage, and stand pipe connections would be run up where required. It is also proposed to place two feed pumps in the pump room of economical type and from these run two feed mains, each connected independently to each boiler. A constant pressure would be maintained in the feed main, slightly higher than boiler pressure, to ensure reliable feed. In the pump room also there would be two small fresh water pumps connected with the water tanks and with a main in the central passage with necessary branches. Interior ventilation would be provided for by electrically driven fans connected with a main air duct in the roof of the central passage. From this branches would carry fresh and, if need be, heated air to the living spaces, thus getting rid of the present steam heating systems. For cooling the magazines a small electric motor-driven air compressor would be fitted supplying dense air to the magazines. Light and power transmission by electric current is referred to, the engines and boilers being located forward of the forward boiler room, and the feeders arranged to be carried fore and aft in the central passage. Means of interior communication are next discussed, the suggestion being made to increase the inside diameter of the armored tube leading down from the conning tower, so that a man could go down for inspection and repair work. The various signaling connections, mechanical and electrical, would be carried the length of the ship inside the central passageway, branching out at such compartments as needed in. Lastly the author treats of water-tight doors with practically these recommendations: Careful design to reduce number of doors; all doors except coal bunker doors to be hinged and locked by one lever; abandonment of "complicated mechanism" for closing doors from distant parts of the ship; additional stiffness in door frames. All doors from the central passage would open into the adjoining compartments and be fitted with rubber joint so that if a compartment was flooded the door would remain tight. Brief reference is made to the central passage system in certain British naval vessels which, however, is an ammunition passage rather than a subway for purposes of distribution of power, light, etc. The paper contemplates the extensive use of the electric drive and the confinement of the use of steam to the machinery spaces proper.

The reading of the paper was accompanied by running comment by the author, in the course of which he said: "Regarding ventilation, experiments at the Union Iron Works had shown the great advantages of a pressure system over a vacuum system chiefly on the grounds of habitability. In practice, too, the plan of blowing in warm air in winter and cold air in summer had been tried in the saloons of a ferryboat carrying 3,000 passengers, and had been entirely successful. This was a question which in relation to the cooling of the magazines on the naval vessels called for intelligent discussion.

DISCUSSION.

F. B. King opened the discussion by calling attention to the construction of the monitor. John Ericsson, he said, had built and launched this vessel with her steam machinery complete in 100 days; and he drew a comparison between the simplicity and celerity of construction of the monitor and the complications and delays in the construction of naval vessels to-day. He proposed a continuity of naval policy of uniformity and standardization. Vessels to be confined to the fewest possible classes, and simplified in design; a unit system of construction control adopted, so that as far as possible ordnance, machinery and hull could be made up of numbers of identical parts; only Government designs to be used, and these to be complete in every detail, leaving no room for inspection disputes or local changes; bonus to be offered for fast construction, and steps taken to train up a class of men who could build a warship in the minimum of time.

Naval Constructor W. J. Baxter said he had read a paper on the subject before the Naval Institute several years ago—it didn't have much effect. There were two additional reasons for the lack of simplicity. One was the demand made upon shipbuilders by the people who go to sea. As to drainage pipes, however, the tendency was to get rid of these, and in vessels that he had refitted he was able, by proper representations, to get rid of the hand pumps, and thus of about 50 per cent of the drainage pipes. The other reason was that people who designed ships paid too much attention to possibilities and provided too many appliances (gewgaws), which were either not understood by those supposed to use them or not kept in a high state of efficiency.

Naval Constructor Francis T. Bowles was much interested in the simplification of design of warships and resultant cheapening of cost—matters to which no attention were being given. "We are running riot in the expense of our vessels and in the expense of maintaining them," he said. Any suggestion of emergency shipbuilding, however, was regrettable, and as to the monitor, she was "noble in conception, but horrible in detail." He did not wish to underrate the genius of Ericsson, but in all his work Ericsson went a long way round to reach the desired result, and the speaker knew a very distinguished man who said he would not permit Ericsson to design a wheelbarrow for him. With reference to the central passage idea, this had been worked out probably more extensively in the *Texas* than in any other ship of the Navy, and had proved a valuable feature.

Barnum W. Cowles believed in simplification, and to that end had worked out his plan for closing water-

tight doors. On the *Maine* the pneumatic system had been adopted and a central station used for the air compressor run by electric power. The machinery would only take up 30 in. by 40 in. floor space, and would weigh inside 1,000 pounds.

Naval Constructor W. L. Capps approved of the scheme proposed in the paper in general, but believed that the main question was the human one. Until everyone thought alike there could never be complete uniformity.

Naval Constructor John G. Tawresey said: "It is not that we have not thought of these things, but it takes something more than thinking to carry them out. I would not attempt to say which are the most important features of the paper, but one or two of them appealed to me more than the others, because I did try to carry out some of them, with little success. The chief obstacle I found was the contractor. The contractor was very anxious to go right ahead with the work and have no change made in the plan. The particular feature is transporting the coal fore and aft above the deck and in dropping it into the lower bunkers, and then through the lower bunkers into the fire room. I did not see why the coal stowed above the protective deck should not be delivered at the mouth of the furnace and the coal in the lower bunker kept in reserve. I appreciate, too, what is said about ventilating and supplying air to the compartments, instead of exhausting it from the compartments. I have been in favor of that for a long time, and have had a great many controversies about it. I think we are gradually working around to that system on all the ships."

George W. Dickie, in responding, said the question of cooling magazines was of hign importance to the Departments of Construction, Engineering and Ordnance.

Cecil H. Peabody doubted if the plan of cooling suggested by Mr. Dickie would work.

George W. Dickie referred to a test made in the magazines of the *Wisconsin*. These were heated up artificially to 115 deg. and then a 3-4 in. compressed air pipe was run in, with the result that in the first four minutes there was a reduction of 8 deg., and in twenty-eight minutes the temperature had dropped to 69 degrees. The quantity of air used was not recorded. He had had experience with very hot workings in mines—blind drifts where rock drills were operated by compressed air—and it was almost impossible to prevent the miners from cutting holes in the compressed air pipes and thus cooling the drift. "There is no doubt," he said, "that by liberating air under pressure at the floor of the magazine and letting the magazine fill with cool air—just as you fill a tank with water—the warm air will escape at the top, and this will accomplish the purpose. The idea at present is to use ice making machines and put pipes on the sides of the magazines; but I think it will be found that these pipes may get pretty cold, and yet little or no reduction of temperature in the magazine result." As to the operation of bulkhead doors referred to by Mr. Cowles, the Union Iron Works have in operation a hydraulic system for opening doors in the yard. The storekeeper, for instance, sat at his desk, and by moving a little valve opened or shut a door 50 ft. by 25 ft. in dimensions. In the case of the hydraulic system fitted in the *Monterey*, the doors were operated by hand apparently because it was too much trouble to start the pumps to operate them by power.

BEAM FORMULÆ APPLIED TO A VERTICALLY STIFFENED BULKHEAD, WITH SOME RESULTS.

BY H. F. NORTON.

This is a purely scientific discussion of the subject described in the title and is supplementary to the paper entitled, "Test of the Strength of a Longitudinal Bulkhead Separating two Engine Rooms," read by Naval Constructor J. J. Woodward, at the previous meeting of the Society. The tests were applied to a bulkhead of the battleship *Illinois*, under construction at Newport News. After referring to that paper Mr. Norton says: "In order that a more intelligent idea of the reasons for the action of the bulkhead test might be obtained, a mathematical analysis of vertically stiffened bulkheads under water pressure was worked out." In this paper the process followed and the results obtained are set forth. In opening, the author states his premises thus: "Unless the bulkhead is so small and the deflection so large that the plating acts as a tie in some direction, it is practically relied upon only as a water-tight diaphragm, the rigidity of the bulkhead against pressure depending almost entirely upon the stiffeners, the plating entering as a factor only so far as it may be considered to form a part of the stiffener. In the case under consideration these stiffeners are vertical, spaced equally, and bracketed at the heads and heels. We then assume that the stiffeners must bear the whole burden, that each takes its equal share, and that the load upon each consists of the water pressure upon a strip of plating extending an equal distance on each side of the stiffener. In supporting this load we assume that the stiffener acts as a beam, conforming to the laws of flexure, and that the bracketed stiffeners act as beams fixed at the ends. Since the bulkhead is vertical the water pressure upon any point will depend upon the distance of that point below the surface." Then follows the mathematical treatment of the subject as adopted by the author. In the course of this it is shown that the results reached by computation vary from those obtained by observation to a degree that might reasonably be expected, and which shows that our present knowledge of the controlling conditions does not permit of exact theoretical determinations. The variation, however, was not irregular, but exhibited well-sustained relation to the actual measured deflections, and more clearly showed the necessity for a further accumulation of experimental data. In concluding his paper, the author disclaims any intention to "build up any new theory on this one case," but simply offers the results as a contribution to the fund of knowledge out of which the satisfactory treatment of bulkheads may be evolved. In the form of an appendix the mathematical processes of reasoning are given in detail in specific cases, and a chart with graphic treatment is included.

No discussion followed the reading of this paper, which was presented by the author.

NOTES ON SHEATHING THE U. S. S. CHESAPEAKE.

BY NAVAL CONSTRUCTOR LLOYD BANKSON, U.S.N.

This is a practical description of the work done on the new Naval Academy practice ship *Chesapeake*, the first American naval steel hull vessel to be sheathed. She is a ship-rigged sailing vessel, in dimensions: Length, on water line, 175 ft.; beam, extreme, 37 ft.; draft, mean, 16 ft. 6 in.; displacement, 1,190 tons. The ship was designed by the Bureau of Construction and Repair and built by the Bath Iron Works. Specifications for sheathing called for a teak keel, white oak false keel, and Georgia pine planking to extend from the keel to about 26 in. above the water line amidships. The planking to be worked in one thickness, 4 in. thick, reduced to 3 1-2 in. for the two top strakes and at the ends; and to be 9 in. wide amidships and on the sides about 8 in., tapering forward and aft to make fair work. For fastening 3-4 in. naval brass screw bolts were specified, these to be screwed through the plating between frames with brass nuts and iron washers on the inside. At commencement of the work it was found the planking had to be steamed to make a good job. It was not practicable to put the plank in place, mark the holes from the inside, then take it down and bore the holes square with the inside surface, though the specifications called for the drilling of the plating first. Accordingly the holes were first bored in the planking when it was in place, then the plating was drilled and tapped, and lastly the plank holes were counterbored to take the heads of the bolts. The bolts were put in with a hemp grommet under the head and with red lead putty, the bolt being well hove up by pneumatic tool before the nut was put on inside. When the nut was jammed down centerpunch marks were used on nut and bolt end to show they were tight. Before fitting the plank the hull was tested for watertightness and all leaks stopped. The skin plating had been previously pickled and, after cleaning, a coat of red and white lead was laid on. The plating was fitted in the usual manner with inside and outside strakes. After sheathing the planks were bored at intervals and lead putty was forced in at pressure to fill up all interstices between the planks and hull plating. Care was taken to have the planking beveled to leave a good seam for caulking and avoid the use of the reeming iron. After caulking the seams were payed with hot pitch. Whenever possible the butts of planking were located between frames. Difficulty in making watertight work by caulking was met with between the stem and stern post castings and the outside plating. Where bolts fetched up against a bulkhead in out-of-the-way places, before they were flush with the sheathing, they were withdrawn and shorter bolts substituted. In these cases no nuts were employed. The bolts used were made of: Copper, 62 parts; Silesian zinc, 37 parts; tin, 1 part, and had a tensile strength of about 47,000 lb. A list of weights gives totals of: Fastenings, 11,883 lb.; sheathing and filling, 162,313 lb. The approximate area of sheathed surface is 7,583 sq. ft., and weight of materials per square foot, 27 lb.—in both cases keels are omitted. The sheathing is bound at the top by an angle 3 in. by 3 in. by 7 lb., weighing 2,345 lb. The time consumed in the work, exclusive of Sundays and holidays, was: Planking, 40 days; caulking, 26 days; pumping putty, 17 days.

There was no discussion on this paper.

Third Technical Session.

On Friday morning there was a considerable attendance of members in the hall when the Chairman, Rear-Admiral Bunce, U.S.N., called the meeting to order at 10.30 o'clock, and announced the reading of the first paper on the programme.

SYSTEM OF WORK IN A GREAT LAKE SHIPYARD.

BY W. I. BABCOCK.

In this paper the author describes with much minuteness the methods employed in the shipyard at South Chicago, Ill., in the construction of the ordinary type of lake freight steamer. The special aim of the management is to economize by the use of methods of duplication in construction and to this the special form of lake steamer readily lends itself. By way of preface the author describes the typical lake steamer and sketches the special requirements of the service. Nearly all modern steel lake vessels are designed to carry only ore, coal, or grain in bulk, and consequently no deck is required over the main deck beams in the cargo holds. The movement of ore and grain is entirely from the upper to the lower lake ports, and of coal in the opposite direction. Competition of modern vessels and necessary slowness in unloading coal often causes the big steamers to return light. Ice limits the season of navigation to seven months and dispatch in ports is a necessity. Cargoes are spouted in and unloaded by machinery on the docks, so no hoisting machinery is carried. Shallowness of connecting channels between lakes calls for vessels with plate keel, very flat floor and full model—a large number of frames amidships are thus alike, as many as one-half to two-thirds the total number. When light at dock such vessels float very high out of the water, and to obtain the necessary slope to the spouts the hatches are made as wide as possible athwartships, leaving only stringer enough for strength on each side. The upper deck could be depressed by filling the water bottom, but this would cause loss of time in loading; cargo can be run in faster than water pumped out. The longest and straightest run in open water is across Lake Superior, about 400 miles, and the total voyage is less than 1,000 miles. Fuel is easily had at points in the connecting rivers, and is loaded through fuel hatches in the upper deck by a spout. At lower lake ports the vessel while unloading, is coaled from a lighter, with derrick, alongside. Danger of grounding in channels calls for double bottoms, which are carried straight across on top to protect the bilge to the upper turn. To get sufficient water ballast, and to raise up an ore cargo so as to make the ship easier in a seaway, the tank is made deep—5 ft. to 6 ft. at center line. As a consequence, heavily-stiffened and closely-spaced girders or longitudinals are needed. These are intercostalled between the floors to support them and the bottom plating from grounding strains. The use of channel iron floors for the flat of bottom is general and effects a saving in first cost, and also avoids shearing of rivets and crack-

ing of frames from grounding, as in the ordinary construction. Ore and coal loading docks have the spouts spaced 12 ft. centers and all hatches are spaced 24 ft. centers, fore and aft; and frame spacing is always 24 in., the frames being channels. Hatches are 8 ft. fore and aft and channel web frames or belts are spaced 8 ft. apart; making one belt at each hatch beam, and one in the center between hatches, on which a main deck beam is placed. To suit the spacing of loading spouts as well as to avoid a shaft alley in the cargo hold the machinery is as far aft as possible. Engines near stern post, boilers and bunkers next forward, either in hold, or on a raised deck with cargo space beneath. A vessel built to these trade requirements—S.S. *Mauna Loa*—at the yard has the following characteristics: Length, keel, 430 ft.; over all, 450 ft.; beam, moulded, 50 ft.; depth, moulded, 28 1-2 ft.; water bottom, 5 1-2 ft. deep; engines quadruple expansion, four crank jet condensing, of about 2,500 horse power; boilers, Babcock and Wilcox, marine type, working at 250 lb. pressure; light load displacement, 3,200 tons; carrying capacity, 6,816 gross tons (iron ore) on 18 ft. 3 in. draft; water ballast capacity, 2,900 tons; speed loaded, 12 statute miles; speed light, 14 miles. Details of the yard and the methods employed in the construction of this and similar vessels are then given. Advantage is taken of the form of the ship to order a large quantity of material—plates and shapes—in duplicate pieces from the mid section as laid on the mould loft floor. When the lines are faired and body plans completed on the floor the remainder of the material is ordered in the usual manner. Extensive use is made of wooden moulds to get out material, so that sufficient plates and shapes for almost the entire water bottom for the straight midship body, and for a considerable length forward and aft of this, can be gotten out rapidly from a few moulds, before the keel is laid. All pine moulds for butt joints are provided with adjustable lignum vitæ strips at the ends, so that swelling or shrinking of the softer wood can be compensated for. For lap joints this is, of course, unnecessary. Points are given concerning the use of moulds, the laying down of the ship (broadside launch) the assembling of the material, and construction of the hull, and in conclusion the author discusses the question of how far the mould system may be carried with economy. After an experience with thirty vessels built under this system he is of the opinion that it "is the cheapest known, and can be applied to a large extent with great advantage in any yard where large ships are built."

DISCUSSION.

Naval Constructor William J. Baxter opened the discussion by remarking that those who had to do with the building of warships endeavored to get as many wrinkles from the Great Lakes as possible. He considered the paper very valuable as an exposition of an American method of building ships.

George W. Dickie said: "It is startling to the ship builder who does not know practically what methods have been adopted on the Great Lakes to find how simple a thing a ship can be made, if it is so desired. In looking at the midship section of this vessel, the first thing that strikes one is the method of carrying the inner bottom to the side of the ship. This is not the usual method in seagoing vessels, and why it has not been adopted has always been a matter of surprise to us. We have proposed it many a time. Drainage has been considered as an obstacle to the carrying out of this plan. But where a vessel has considerable deadrise which this vessel has not, and the drainage can be brought to the middle of the vessel instead of to the bilges, as is usual in double bottomed vessels, there is no reason why it should not be carried out. It is also a matter of great safety. We had on our dock last month a vessel, the *Matteawan*, that had been ashore in the Straits of Magellan, with her whole bottom practically out. Fortunately for her the absolute penetrating of the plates did not extend beyond the boundary plate of the double bottom. Had it done so the vessel could not possibly have been saved. The bilges were all out of shape, but at no place was the plate actually fractured outside of the line of the double bottom, but here we have a vessel that is safe for a height of practically six feet. Another startling thing to most shipbuilders is the fact that a vessel of 430 ft. in length can have practically 288 ft. from one mould. We never would have expected this. I do not see why it should not prevail in seagoing vessels as well as in lake vessels; but as yet we have not been able to do much in that line. The fact of the engines being close to the stern also permits of this mould system throughout the midship section of the vessel, the frames being all alike. Usually in our practice we have an entirely different method of framing, right in the middle of the ship, under the engines and boilers—more intercostal work, and difficulties that would interfere with the carrying out of the system."

James Dickie, of the Union Iron Works, in a communication, said it was not possible to carry the system as far on the seacoast as on the lakes. In vessels that went on long voyages, for example, it was not possible to put the engines at the stern, for a vessel using from 1,000 to 1,500 tons of coal on a voyage would be very much down by the stern when loading, and very much down by the head on arrival, unless half of the coal was stowed at the forward end. This would mean a conveyor for carrying the coal aft, and then the extra cost would offset the advantage. Oil vessels were built that way, but the cargo carried made the problem of trimming a simple one. Further, it was not advisable to build ocean-going vessels with so long a straight body and full ends; and, again, with the engines near amidships enough rise of floor could easily be had to secure proper drainage. In getting out work the San Francisco yard used very much the same system, the difference being that battens and gauges were used wherever possible, and templates instead of moulds. The templates were 1-8 to 3-16 in. thick, and instead of being bored with holes the center punch was driven through them, making very accurate work. On one occasion the yard had built eleven barges from patterns and templates, only one of the barges being put together in the yard. The others were erected at their destination and proved very satisfactory. In the battleship *Ohio*, under construction in the yard, all the keel, all the longitudinals, the armor shelf, and all the interior bulkheads were gotten out, and the vessel put together, using the longitudinals instead

of ribbands for frame spacing and for the bulkheads to regulate the transverse shapes. It was their experience that work laid out gave more accurate results than the method of building a vessel piecemeal.

Richard L. Newman related his experiences with the mould system in lake practice. Two revenue cutters for the Government were built under this system with the exception of the shell plating. With regard to the lake type of ore carrier he believed that the excessive strength of the tank was unnecessary. When these vessels struck the bottom it was usually necessary to dry dock them for repairs, and it would be better to take a little of the weight from the bottom and place it higher up. It was probable that the mould system would be widely adopted, and would become the rule rather than the exception.

George W. Dickie asked the author if it was true as reported, that it was getting to be the practice on the lakes to carry water ballast loose above the double bottom.

"I have proposed it once or twice," he said, "for some of the ships that have too small ballast capacity for the West Coast. You know we have a very difficult route from San Francisco to the Sound, especially in the summer time, and the boats have been knocking themselves to pieces; and I suggested some time ago, instead of building the deep tanks that we have been putting in quite a number of these vessels, where they carry water only by being fitted with a deep tank, that they might just let the water out above the double bottom and carry it where it was wanted."

Mr. Babcock in reply to Mr. Dickie's question, said: "I cannot say that it is a practice that I thoroughly approve of myself. At the same time it is continually done on the lakes, and has been done for a very long while. I think the principal danger is when a boat is pitching in a head sea—that, however, is the only time that water is admitted into the hold, because the only reason for it is to get the wheel down—the ship going up light against the head sea. The danger is that as the bow rises and the stern falls on the wave the rush of water back may carry away the engine bulkhead or the boiler bulkhead. I never heard of that occurring. In fact, with very long ships, ships over 400 ft., a keel which is now common on the lakes, there is less danger in carrying over water in the hold than in the shorter ships. Although the seas are pretty high they are very short on the lakes, and we find that the long ships do not pitch nearly as badly as the short ones, because they extend over too many seas at one time. But it is certainly not at all an uncommon practice to start a manhole cover off so as to allow the water from the water bottom itself to come into the hold. In fact, we did put in in one or two boats, at the request of the owners, a valve that works from the upper deck through the tank top to allow the water from the water bottom to go into the hold—put in simply to save the trouble with a small crew of having to send a man down below. So far as rolling is concerned, the boats are so very stiff that you may say that the free water makes them easier than if they did not have it. I have known also of two or three cases of wooden steamers, small wooden steamers—for none of them are very large—and of course boats that had no double bottom and no water ballast, ordinarily admitting free water into the hold with a system of floating hatch covers on it. The covers float on 3 or 4 ft. of water and keep it from slashing around too much.

"I might say that on the lakes we are not especially bothered by precedent. The people up there have an idea that if anything appeals to them as being a good thing to try, it does not make very much difference whether anybody else has tried it or not; we go ahead and do it. It is possible, for that reason, that the lake ships are considered to be as well fitted for the peculiar conditions which obtain on the lakes as any class of ships in the world. I say that without being accused of egotism, because I did not begin out there; I have only been there a few years now. A good deal of what has been done was there when I went West. I surprised an Englishman very much the other day, a man who was visiting the yard and who seemed to find fault with everything we did. I told him that it did not make any difference to us how they built ships in England; that we built them the way we thought was right for our business."

Col. Edwin A. Stevens called attention to a feature suggested by the paper: "The success of American shipbuilding as a commercial matter rests on the ability to meet competition." Now that builders were placed on as good a footing here as British builders, in the matter of material, the application of those methods that had brought success to the bridge builder in foreign competition, would, with the skill and intelligence of the American mechanic and engineer, bring success. The evolution of a peculiarly American system of building ships—in the same way that America had evolved a system of building bridges—had been best exemplified on the lakes. In looking into the figures of fuel consumption of lake steamers, the speaker had never been able to find any other figures for moving freight by water per ton mile that came anywhere near the lake figures—and he understood those figures were correct.

Mr. Dickie: "I would like to qualify a statement by Mr. Stevens in regard to the corresponding advantage that the American shipbuilder has to the British in regard to material. I think that we labor here under a very great disadvantage on account of the enormous fluctuations in the price of material. I read the other day an article by Mr. Stevens in which he stated that a great iron master here—of course we all know who he was—stated that he was prepared to construct and lay down material in an Atlantic seaboard shipyard at a less price than the same material was delivered in any British shipyard. That was several months ago. That same iron master is charging £18 8s. 6d. for material in New York to-day for ships, while the British shipyards have it at £7 8s. 6d."

OVERHEAD CRANES, STAGING AND RIVETER CARRYING APPLIANCES IN THE SHIPYARD.

BY JAMES DICKIE.

This paper is devoted chiefly to a description of the methods used at the slips in the Union Iron Works, San Francisco. Brief references are also made, at the commencement, to the manner in which the problem of handling the structural material has been met in various yards at home and abroad. In opening the author calls attention to the increasing need of "overhead" handling appliances, due to the extended use of power riveting.

Other matters to be considered are the staging required during the process of construction and the necessity of keeping the upper works fair during the earlier stages. These matters form a large portion of the cost of construction of a large merchant or naval vessel, and the problem of a structure to facilitate the performance of the four functions mentioned is thus presented. Prior to 1884 the only means of hoisting material was the derrick pole with swinging gaff. Other and more recent methods are: (1) The cantilever traveling crane, such as is used at Newport News. This, however, only hoists material, and provides but one crane for two ships. In criticism of this method the author says the time of hoisting and traveling is comparatively brief, 95 seconds being the average; while from 7 to 12 minutes were needed to secure a member in place before the crane could let go. (2) The overhead crane or gantry, traveling all over the vessel with rails on the ground on each side—much used on the lakes. There broadside launching is used, and so two such cranes can be put to work and moved beyond the ends when launching—but they can only hoist. (3) The gantry at Belfast used for the construction of the *Oceanic*, performing the functions of hoisting and carrying riveters only. It appears to be limited in operation, covering not more than 120 to 150 ft. of the vessel's length at one time, and being so large and heavy, must be slow in motion. (4) The framework which covers the entire vessel while building, with examples at Swan and Hunter's English yard and at the Union Iron Works, and which performs the four functions already referred to. At the 'Frisco yard there are four such stuctures. Three are 300 ft. in length and one 408 ft. long, all of varying dimensions in width and height—the largest 85 ft. wide and 78 ft. high. They are all built of wood and are similar in construction. At each end there is a 50 ft. swinging crane, giving an additional reach of about 100 ft. in length of vessel which could be served. Overhead electric cranes of 5 tons' lifting capacity are fitted in the largest framework, each covering one-half the beam of the vessel. The apex of the roof is off center sufficiently to permit one of these cranes to handle material on the center line of the ship. For plating under the bottom and under the counter, hoisting is done by a wire rope rove through the plate and the corresponding hole in the frame and toggled below the plate, and in this way the plate is drawn up close, ready for riveting. All the posts of the structure are spaced 12 ft. centers and the construction lends itself readily to staging, the plank for this purpose being 2 in. by 12 in. by 26 ft., which is strong enough and easy to handle. In the new slips it is proposed to fit up light cranes of 8 in. T-bulb beam, each supported by two suspension rods. These will be placed on opposite posts and fitted with trolleys from which there will be hung a cross beam, and on this the riveter will be suspended from a trolley. The cross beam can be raised or lowered as required. These cranes will each have a reach of 32 ft., so that there will be sufficient space between the inner ends for the overhead cranes to carry material the length of the ship. Thus, hoisting and riveting can go on simultaneously. With this structure no side shores are used above the bilge, and for fairing the upper works turnbuckles are used reaching from the sides of the ship to the structure. These can be readily lengthened or shortened by men on the upper staging. The riveters used are toggle-jointed air machines that drive 7-8 in. rivets with 30 in. gap, and weigh 1,400 lb.; also percussion air machines, with 4 ft. or 6 ft. gap and weighing only 250 lb. Several scale drawings and photographs accompany the paper.

In the absence of the author the paper was read by the Secretary.

DISCUSSION.

HENRY G. MORSE referred to the successful operation of the gantry crane (one crane for two ships) at Newport News and at Cramps. The Union Iron Works used two cranes to one ship, which plan, though possibly best for a very large ship, might not be so for an intermediate size. He believed the best plan would be to have one crane for a small ship, two for the next larger size, say a large coastwise steamer, and three cranes for ships of the largest size—liners. Two cranes on a very small vessel meant an extra motorman and gang for handling material. At Harlan & Hollingsworth he had put in a single crane for one ship and they had to work overtime to get the material on board in time for work. This was chiefly because the plates were laid out before the frames were up—400 or 500 plates laid out by templet were ready to be raised into position.

JOHN PLATT said that Harland & Wolff put in their crane only for very big and very long ships. This gantry was not primarily for handling material—it was a riveting gantry more than anything else. Harland & Wolff endeavored to handle material on the ground, on cars, as much as possible. There were four jib cranes attached to the gantry, covering the portion of the ship under the gantry, and these were operated hydraulically and moved the riveters about. The riveters were very heavy, having a 6 ft. 6 in. gap and applying 40 tons pressure on the rivet. The rivets used in the *Oceanic* were 1 1-4 in. dia., and as there were butt straps and cup head rivets all above the water, heavy rivetting was needed. This was the first time these heavy rivets were closed by hydraulic power. When the ordinary store rivets were tried first it was found that they were 1-2 in. too short—with the machine exerting 40 tons pressure on the rivet an additional 1-2 in. in length was required. The big gantry moved slowly but was readily handled by hydraulic engines, and speed in locomotion was not called for.

MR. MORRIS in criticism said the Harland & Wolff crane had only a range of 150 ft., and so with a ship 700 ft. long it could only reach a small portion of the ship at one time. With seven such machines he believed the ship could have been built in one-third less time, especially if the plates were laid off before hand.

MR. PLATT replied that the *Oceanic* was built in the least possible time, conditions considered, and Harland & Wolff were so well satisfied with the gantry that they had ordered three more of similar size to go over new slipways.

GEORGE W. DICKIE believed that everyone engaged in shipbuilding preferred his own tools which were evolved to suit his special wants—local questions of labor, etc., entered into the matter largely. In the last slip finished at the Union Iron Works provision was made for two cranes on each side—four cranes to a ship. In construc-

tion these cranes were very cheap, four could probably be put in operation for the cost of one large single crane, such as is used elsewhere for two ships. The staging possessed great advantages in erection.

DESIGNS FOR DENVER CLASS SHEATHED PROTECTED CRUISERS.

BY CHIEF CONSTRUCTOR PHILIP HICHBORN, U. S. N.

This paper describes the chief characteristics of the proposed new cruisers, designs for which were prepared during the past year. In authorizing the construction of these vessels Congress also provided for three battleships and three armored cruisers, with the further provision, however, that no contracts for the hulls were to be let until contracts had been made for the necessary armor plate. The price of armor was at the same time limited to $300 a ton, and as no bidders responded at that figure the designs for these two classes of ships were delayed, and are thus not presented with this paper. The question of armor not entering into the construction of the small cruisers, the plans were completed and bids entertained. The proposed vessels are about the size of the *Raleigh* and *Cincinnati*, which, though classed as 19-knot boats, were never able to maintain a rate of speed even approximating to this. The *Raleigh* when with Dewey's squadron could only steam with difficulty at the rate of 9 knots, using three-fifths boiler power. Coal consumption was also limited. In the new vessels no attempt has been made to secure "fancy" results, but they have been designed for hard service, having in view especially the offensive and defensive qualities, suitable speed, durability, habitability, and the independence of coaling and repair stations as far as possible. A displacement of 3,200 tons and a speed of 16 1-2 knots was decided upon. The bunker supply is 700 tons, giving a full speed radius of action of 2,500 knots, and economical speed radius of 7,000 knots—or a continuous trip from San Francisco to Manila. The construction is unusually heavy. There will be a 1-2 in. protective deck, but no ram, and the vessels will be sheathed and coppered. All woodwork will be fire-proofed, and corrugated metal freely used. Liberal allowance has been made for machinery weights, which will be 10 per cent heavier than in the *Raleigh* or *Detroit* classes. The engines will be vertical inverted, triple expansion, of 4,500 I.H.P., with cylinders 18 in., 29 in., and two 35 1-2 in. by 30 in. stroke, to work up to 172 revolutions. Water tube boilers (6) will have about 300 sq. ft. grate surface and 13,000 sq. ft. heating surface, and will carry a working pressure of 275 lb. Auxiliaries and other apparatus will include distilling plant, ice machine, refrigerators, electric ammunition hoists, winches and blowers, searchlights and signalling apparatus. The electric generating plant will consist of four units, each of 300 amperes 80 volt capacity. Armament will include ten 5-in. guns of 50 calibers length, and eight 6-pounders, two 1-pounders, four automatic guns and one field gun. Nickel steel protection for the guns' crews will be provided. Ammunition will be carried in considerable quantities—250 rounds for each 5-in. gun and 500 rounds for each 6-pounder. Smokeless powder will likely be used for all guns. Much care has been given the berthing of the crew, the ship's complement being 263, including 27 marines. Additional accommodation for a total of 450 men can readily be improvised in the available space, and the vessels will thus be useful in transporting relief crews to foreign stations as need be. The author alludes to comparisons drown by critics between the foreign-built cruiser *New Orleans* and the ships of the *Denver* class, and shows that the latter excel in the requirements of practical service. "I do not pretend to criticise the design or construction of the *New Orleans*," he says, "but she is essentially a 'show' vessel, cleverly designed to that end, but no such design as would be found emanating from the British Admiralty or our Navy Department." Or, in other words, "she was designed purely for speed and the heaviest battery the law would allow." Plans of the new vessels accompany the paper.

In the absence of Constructor-in-Chief Philip Hichborn, U. S. N., the paper was read by Arthur Cassidy, of the Bureau of Construction and Repair.

DISCUSSION.

Engineer-in-Chief George W. Melville, U. S. N., in a communication read by Mr. McFarland, said that in reading over the paper on the *Denver* class he thought that the Chief Constructor need not have felt called on to defend the design, inasmuch as it was decided upon only after very careful consideration by the Board of Construction. He was sure the expert officials of the Department knew the needs of the service, and how to fill them, better than the newspaper critics. He noticed with regret some statements in the paper concerning the *Cincinnati* and *Raleigh* which would have a tendency to create an erroneous impression about those vessels. These statements quoted by the writer were to the effect that, "owing to certain well-known conditions," the cruisers were never able to maintain a speed even approximating to the rated 19 knots for any length of time, and also that the *Raleigh* when with Admiral Dewey's squadron could only with difficulty steam 9 knots.

"I am sure that he (the Chief Constructor) could not have intended to give other than a correct impression, and can only attribute these statements to the fact that he was not in possession of full information," continued the Engineer-in-Chief. "As I am enabled to give the actual facts from the logs of these vessels, I shall show that the *Raleigh* has on a number of occasions made an excellent record; and, further, that the general statement with respect to the speed of 9 knots while with Admiral Dewey's squadron, and which as it stands might be supposed to refer to the home cruise, is entirely erroneous. First, however, let me say that the *Cincinnati* and *Raleigh* were designed at a time when there was a perfect craze for high speeds in all classes of vessels. The statement had been dinned in our ears so long that we must get at least as good results from every ship as were obtained from foreign ships, and must, if possible, do better; that our designers were really working, as one might say, under the lash. Just before these designs were prepared the British Admiralty had gotten out designs for what were known as the 'M class of cruisers,' which had exactly the characteristics of the *Cincinnati* and *Raleigh*—large power in a small hull. The history of those ships has been very much the same as the history of ours, in that they have not been a brilliant success, and that the English, as well as our-

selves, have realized that it is unreasonable to sacrifice too much to speed in a small cruiser."

Owing to the fact that the *Cincinnati* and *Raleigh* were built in the Navy Yards there were no trial trips under the usual conditions of acceptance from private builders, and, although it had been the intention to have such trials, the need for the vessels caused them to be put into active service as soon as they were completed. The *Raleigh*, after having been in commission about two years, and without any special preparation, was given a four-hour trial March 25, 1896, with her regular crew. The wind and other conditions on this occasion were unfavorable and trial took place in comparatively shallow water, ranging during the first two hours from 14 to 17 fathoms, and at no time exceeding 25 fathoms. Under these circumstances the best results as to speed could scarcely be expected; but, nevertheless, on a displacement of 3,574 tons (about 400 tons more than design) the average speed obtained was 18.64 knots, while during two hours of the trial the average was 19.27 knots. Captain Miller, the commanding officer, had reported at the close of the trial that, with the exception of the middle fire-room blower, everything was in good working condition. Very few men in the ship had ever had any experience in firing with forced draft, and the coal was the run of the mine.

As to the statement that "the *Raleigh* when with Dewey's squadron was only able to steam with difficulty at a speed of 9 knots, using three-fifths of the boiler power," it is to be remembered that the *Raleigh* had not been docked for about seven months previous to the battle of Manila, and that, in consequence, her bottom was very foul and the speed was thereby necessarily materially reduced.

As the *Raleigh* had recently returned from Manila, it was of interest to quote from the official records as to the speed on the return trip under the fractional (three-fifths) boiler power alluded to. On the trip from Bombay to Aden, a distance of 1,642 knots, and with slightly less boiler power in use than during the Manila fight, under natural draft in a tropical climate, and with no special effort to make time, an average speed of 13.14 knots was maintained. After arrival at Aden there remained sufficient coal for 928 knots, or an endurance of 2,570 knots at the speed mentioned. Leaving Aden an average hourly speed of 12.78 knots was recorded for the next 1,300 miles, with the same boiler power in use. These runs were not cited as "fancy figures," but simply as indicating what the ship has readily done under ordinary conditions.

An examination of the same log-book showed the fact that ordinarily, and for economy in coal consumption, the *Raleigh's* speed in cruising did not, as a rule, exceed 12 knots, and generally was below that figure. Many instances, however, were recorded where the speed was materially greater, and on one occason (October 12-13, 1896), during a trip between Hampton Roads and Smithport, N. C., when speed was apparently important, an hourly average of 15.9 knots was maintained for sixteen hours under natural draft with about five-sixths boiler power.

He was glad to indorse the remarks of the Chief Constructor with respect to the importance of adequate coal supply, and also of proper internal arrangements. It was well known that in these respects both the *Cincinnati* and *Raleigh* were very defective and the experience with these vessels had brought to the attention of designers in the most marked way the importance of providing for the human element. When the *Raleigh* and *Cincinnati* were being designed the writer had urged upon the then Chief Constructor the importance of increased length, so as to give proper room for the care and operation of the machinery. Even now he is of the opinion that to cut the vessels in two and lengthen them, say, 20 ft., would be good policy. The advantages of such alterations were apparent in the *Castine* and *Machias*, and in several well-known liners. It was valuable to find the views of the Chief Constructor on record so fully, as to the importance of real resuts in every-day performances, rather than phenomenal records for a brief trial. At the time the *Cincinnati* and *Raleigh* were designed the professional men of the Department were not in a position to take such a stand, but in the meantime many ships had been built and sufficient experience gained to warrant the stand taken.

George W. Dickie expressed pleasure at the stand taken by the Navy Department in the design of these cruisers, and naval architects in general, so far as he knew, were in accord with the Department. He was personally opposed to the use of soft wood for sheathing, and favored the use of teak. It had been suggested that this was not a home product, and the law required that the vessels be built of material of domestic manufacture. To this he would reply that the sheathing of electric wires in vessels of the Navy was composed of India rubber which was not of domestic growth at all. (Laughter.) Teak possessed wonderful properties for the preservation of iron and steel, and no other wood had this quality. "The wood itself is practically indestructible," he said, "and the renewal of sheathing on one of these vessels where so many fittings have to be removed is a very serious matter. When you spend a million dollars on a cruiser I don't think that the seven or eight thousand dollars difference between pine and teak should be considered at all." He did not think that the cost was considered, but that the matter was one of sentiment.

Naval Constructor W. L. Capps said the paper marked a "distinct increase in technical backbone." It showed a willingness to take less speed in the beginning than could be had, because those in authority believed the lesser speed was better. High speed was only obtained at the sacrifice of many vital characteristics, the most vital of which was coal supply. High speeds in the past were trial trip speeds and not cruising speeds. Under practical conditions they were obtained ordinarily in smooth water, with clean bottoms, highly trained crews, and picked coal. In actual service, conditions were, usually, foul bottom, ordinary crew and any coal that could be got. Referring to the *New Orleans* as a "very brilliant design," he said the large bunker capacity on that ship was obtained only at a very serious sacrifice in habitability. "The bunkers are raised aft above the protective deck and the men have to sleep on these in the tropics. I have just returned from a trip to the tropics under just such conditions as the *New Orleans* will have to confront, and do not at all envy the lot of people who have to sleep below—of course they will sleep on the upper deck and there they will frequently get wet." He believed that the change

in the policy was largely due to experiences in the late war. It was then shown that paper speed was not real speed, and that the coal supply was inadequate.

Captain Charles L. Ottley, R. N., followed and said: "Every officer who has had anything to do with squadron cruising, who has had much to do with the work of ships together, first of all plainly realizes that the speed of the squadron is necessarily the speed of the slowest ship, while an officer in command of a squadron who has to go from one place to another, if he is under orders to proceed with dispatch, wants to know what his maximum speed is. Upon that he can base his plan of operations whatever it may be. But what I desire to speak of and what I have seen many a time in squadron cruising is when an Admiral has put to sea we will say, with a number of ships of nominally 14 knots speed, these 14 knot flyers occasionally tail off in the most disappointing way. I entirely agree with the gentleman who spoke last as to the splendid line that the U. S. Government has taken—the people who are responsible for the designs here—in saying that the speed the ships are designed for is the speed they shall give under the critical conditions of the actual service. That, I think, is the point. I should like also to say that what Admiral Melville said in the memorandum read, about certain of our own cruisers that correspond to your *Raleigh* and *Cincinnati* class is perfectly true. The "M" class of cruisers, the *Magicienne*, *Melpomene* and *Medusa* class, were not everything that is to be desired. I think it is a matter of evolution, and as years go on of course we improve our ships, and no doubt we shall get very much better. But in any case I think what sailors all pray for is: 'for Heaven's sake don't give us a trial trip speed, give us a speed which we can have under all conditions,' and I think there is great hope of obtaining that in your new designs. You will know the speed the ships can go."

Walter M. McFarland: "Having read these remarks of Admiral Melville, it will perhaps be considered that my voice has been heard enough on this subject. But there is one point on which there is a tendency to be a little unfair. I think Admiral Melville in his paper called attention to it, and complimenting Chief Constructor Hichborn for drawing attention to the point, emphasized the fact that at the time some of these ships were built (which were not altogether satisfactory) everybody was young at the business. Mr. Bowles and myself helped on some of the earliest work done for our new navy. I remember very well the talks he and I had, and our doubts as to whether the results could be accomplished. But we were met every time by the statement: 'They are doing it abroad, and if you do not do it it will simply be a confession that people in the United States cannot do as well as people abroad.' It was perfectly useless to say that these ships would only make these speeds for a few hours. You were met with the statement that 'They are doing it abroad and you have got to do it.' So I do not feel that the designers in the Navy Department are to blame in the slightest degree, and as Captain Ottley says, it is a process of evolution. And now the time has come when we have had all this experience, and the general public as well as the experts are educated up to the point. Now we are in a position to recommend and to get it listened to, to do just exactly what really is right."

Arthur B. Cassidy: "I would like to say that I saw the official communication that the *Raleigh* was only able with difficulty to attain a speed of 9 knots. It was the official report of the commanding officer who stated that during the second half of the engagement he was barely able to make nine knots, and it was due probably to the foulness of the bottom and also to the heat in the fireroom and engine room, and he was obliged to give way for the *Baltimore* to precede him in the fight. Also on that same endorsement Admiral Dewey made the comment that the vessel ought never to have been allowed to leave the United States, in his opinion."

Mr. McFarland: "But these statements are misleading unless the whole truth is known."

Naval Constructor Francis T. Bowles said, he took it, the question which the Chief Constructor wished to bring out was the necessity for sheathing, and to take the *Raleigh* for that purpose seemed a trifle unfair. The *Raleigh* had other difficulties besides having a steel bottom. "I have always been opposed to the use of wood sheating on steel ships," he said, "and I still maintain that it is uneconomical and unnecessary and involves a great deal of danger to the ship. It may be desirable to have a few sheathed vessels, now that we are going to maintain a considerable portion of the Navy in the Philippines, until we get dry docks built there; but until the dry docks are built I will admit the necessity for sheathing vessels, and no longer. The questions at issue had been threshed out many years ago."

Fourth Technical Session.

On Friday afternoon the members were called to order at 2.20 o'clock, Walter M. McFarland in the Chair.

NOVELTIES IN SHIP FITTINGS.

BY ASST. NAVAL CONSTRUCTOR R. M. WATT, U. S. N.

Descriptions of improvements and developments in the fittings of naval vessels which have been adopted by the Construction Department at the Brooklyn Navy Yard are given by the author. Those selected for presentation in this paper include: (1) Watertight bulkhead doors operated by electric power; (2) Non-conducting, non-inflammable, non-splinterable sheathing for living quarters; (3) Metallic folding berth; (4) Watertight metal skylight. The requirements had in view in designing the door were: Door to be raised or lowered by power or hand by operator at door on either side of bulkhead; that door should close against a rush of water or through coal on the sill; that operation of the emergency (distant) closing should not interfere with usual local methods of operation; that while door is closing from distant station a man at the door can stop it for egress. Electricity was selected because of the "certainty of control." Cutting off current cuts off power—there is no expansion of fluid, no leakage of valves, etc., and there is no waste of energy when not in operation. The conductor can be readily run around sharp corners and clear of other fittings without frictional losses caused by bends. Breaking a conductor does not release steam or water or create noise. It is admitted that the electric device cannot be applied to all doors in a ship without increase in the capacity of the generating plant. As doors are operated only intermittently, however, by arranging the doors to work singly or in small groups

the system can be applied to the more important doors, by taking advantage of the overload capacity of the generators. Lord Charles Beresford, R. N., has said with reference to watertight doors: "The principle that should be enforced is that it should be possible to shut the door and secure it in one movement." This, the described arrangement accomplished—an operator at the door by pushing a button could close it by power. Another advantage in the electrically operated door is that every door is complete in itself, having its own line from the dynamo room and its own motor. In case of derangement the door could still be operated locally by hand, and one door put out of power operation would not affect the power operation of any other door in the system. With hydraulic transmission a break at the central station would render the entire power system inoperative, and with pneumatic transmission the results would be almost as serious. In construction this door is of the vertical sliding type, with vertical rack in which gears a pinion carried on a horizontal shaft extending across the door at the top of the guide frame. The pinion engages a smaller pinion keyed to a second horizontal shaft, placed slightly above the other, and on the end of this second shaft, outside the guide frame, there is keyed a worm wheel. In this a worm engages, the worm shaft passing through the bulkhead to an electric motor on the opposite side. The ends of the worm shaft are hexagonal, and for these hand cranks are provided. The door and frame are made exceptionally heavy, so as to avoid the possibility of sticking by the deflection of the bulkhead under pressure. The weights are: Door, 291 lb.; frame and gear, 600 lb.; actuating apparatus, 492 lb. Tightness is secured by wedging. The bulkhead frame guides are tapered over one-tenth inch to the foot, and the sliding frame is made with eleven wedges, of the same taper as the guides, which take up in the last half-inch of travel. Both guide frame and sliding frame surfaces nearest the bulkhead are scraped, and when wedged make a watertight joint. The electric controlling devices are described in detail by the author. These and the motor are all incased in watertight boxes. Doors of this type have been fitted in the U. S. S. *Atlanta*. (2) Regarding fireproof sheathing, etc., the practice now followed in the yard was to omit overhead ceiling, and in the crew's quarters the outboard sheathing. In officers' quarters asbestos sheathing is used, and divisional bulkheads are of corrugated metal. Metal is also substituted for wood in berths, ladders, skylights, lockers, and in one case, roll top desk. Experiments are to be made with metal furniture. Asbestos sheathing has been developed by the H. W. Johns Mfg. Co., and is now light in weight and clean, neat and ornamental in appearance, and further adds to comfort by being warm in winter and cool in summer. The weight of this sheathing, with framework and fastenings, averages 6 1-2 lb. per sq. ft. The sheathing consists of successive layers of galvanized iron wire cloth, asbestos fire felt, and asbestos millboard. The seams are covered by metal mouldings, and any interstices are filled with asbestos cement. The millboard is sized, and then painted with white enamel and gold striped. (3) The substitution of metal folding berths for the ordinary brass bedstead gives an increase in available floor space and stowage capacity, and involves a change in the outfit of furniture. Below the berth a shoe locker is fitted, and over the berth a cabinet. When not in use the berth folds up and is neatly hidden by a covering curtain. The additional space permits of the addition of a chiffonier and a locker or transom against the outboard side of the room. There is also supplied a secretary-bureau, metal toilet rings, metal fittings for toilet articles, and the usual china crockery. (4) Wooden skylights over the living quarters are objectionable, owing to leakage over berths and mess tables. This is due to the sudden changes of climate encountered by the naval vessel in service, to the frequent handling in drill in the case of raised skylights and to the jar in target practice in the case of sunken skylights. For these reasons a skylight of sheet copper has been experimentally fitted on the U. S. S. *Cincinnati*, which is water-tight, splinter-proof and non-combustible, neat in appearance, of no greater weight than wood, and gives a larger clear area for the passage of light. A number of explanatory photographs accompany the paper.

DISCUSSION.

Mr. Thomson said incombustible fittings were being used in the Russian battleships under construction at Cramps. Asbestos sheathing is used entirely next the ship's side, and asbestos millboard as the dividing bulkhead between staterooms. All the furniture except the chairs is made of metal, and the decks below the spar deck are sheathed with aluminum, so that the only woodwork on the ships is the deck plank on the upper deck.

Mr. Mackay said, in connection with the operation of the bulkhead doors by electricity, the point was raised whether in case a number of doors were closed in an emergency there would result an excessive demand on the generating plant. This had been considered in designing the electrical fittings for controlling the system, and it was found there were a number of considerations which would bring down the maximum demands for any reasonable number of doors to within the limits of an electric plant on board a ship. The doors could be arranged in groups, say of five or six doors, to be operated by a single push-button and, owing to slight variations of speed in the several motors of one group, it would be very improbable that all the doors would seat at the same instant. The amount of current needed at the instant of seating was greatly in excess of that required to simply close the clear way of the door, but the duration of this required excess was for the fraction of a second only, and probably not more than two or three doors would seat themselves simultaneously. In any event the maximum power capacity required at the generating plant to operate any number of these doors would not exceed one kilowatt for each door, and for an installation of twelve doors experiments had indicated that not more than nine kilowatts would be required. It was unlikely that any ship having, say ten of these doors, would have a generating plant of such small capacity as to be entirely loaded at the moment when the doors were put in operation. In the case of naval vessels the large reserve electric generating plant usually installed would warrant the introduction of the electrically operated door system, without having regard to the overload capacity of the ship generators.

Mr. Erhardt spoke of the advances that have been made in the manufacture and application of asbestos millboard for bulkheads. It was now easily handled without fracture, easily repaired, and could be washed and scraped clean just the same as joiner work.

W. B. Cowles said an objection to the vertical sliding door tightened by a wedge was that when the bulkhead warped the door would jam. He did not know of any possible way of preventing a bulkhead from warping on a ship during her service, while afloat in different conditions in a seaway, and in dock, and a door which did not take account of this was not a door suitable for power operation. For operating doors by power he preferred compressed air to the direct application of electricity, especially where five or more doors had to be operated. He could use electricity with far greater economy to store the air, and thus there would be no draft in time of emergency on the generator capacity. Air also could be led to the doors with less expense and no more interference with surroundings than electricity, and as a fluid it lent itself to a direct push and pull—the work to be performed. He regretted that a more extensive installation had not been used on the *Atlanta*, that vessel not having sufficient generator capacity.

Naval Constructor Francis T. Bowles accepted the responsibility for the invention and installation of the electric system, and said he merely wished to "point out" the difficulties that probably many present had incurred in storing air. (Laughter and applause.)

Assistant Naval Constructor Watt in closing said that the power door had come to stay. It relieved the men of manual labor, and for that reason they kept it in working condition. It was adopted to lessen the complications on board ship, and made use of the form of power which appeared to be coming into use everywhere outside of the engine and boiler rooms. Warping of the bulkhead had been met by a rigid frame of great weight, and it would be easy to increase the scantlings if need be.

PROGRESSIVE SPEED TRIALS OF THE U. S. S. "MANNING."

BY PROF. CECIL H. PEABODY.

This paper is in the nature of a contribution to the collection of data in the proceedings of the Society—a statement of facts and figures. The *Manning* is a seagoing revenue cutter of the following dimensions, etc.: Length, overall, 205 ft. 6. in.; beam, moulded, 32 ft.; draft on trial, 12 ft. 4 in.; displacement, 1,000.7 tons; wetted surface, 7,273 sq. ft. Engines are triple expansion, with cylinders 25 in., 37 1-2 in., and 56 1-4 in. dia., and 30 in. stroke. The propeller is 11 ft. dia., with hub 1 ft. 10 1-2 in. dia., and the pitch is 12 ft. 4 in. The trials were conducted by the author, assisted by members of the staff and graduate students of the marine department of the Massachusetts Institute of Technology. Shortly before the tests the vessel was docked and cleaned and the machinery was put in good working condition. The trials took place in June, 1899, over the measured mile maintained by the Bath Iron Works at Southport, Me. The course is sheltered, has abundant depth of water, and the configuration of the shore and islands guards it against tidal currents. Local landmarks determine the course, and white range poles on shore show up against a background of pines. Trials were conducted in good weather, and there was no perceptible tidal current. The observations taken were: Time required to pass over the course; revolutions and power of engine; steam pressure and vacuum, and form of wave profile. The time was taken with stop-watch from the bridge, revolutions from engine counter, steam pressure and vacuum from engine-room gauges. Two complete sets of indicators were carried, so that in case any indicator showed signs of failing the man in charge could immediately substitute for it a perfect instrument. It was the intention, well carried out, to take five or six diagrams from each end of each cylinder during every run. This the author holds to be a matter of great importance, as the difficulties and uncertainties of determining the I.H.P. are much greater than the corresponding errors in measuring speed. In all fifteen runs were made at speeds varying from less than 7 knots to a maximum of 16 knots, which last was obtained with natural draft and without distress at the engine. For the maximum speed the results showed: Revolutions, 152; equivalent mean effective pressure, reduced to L.P. piston, 38.26; steam pressure near engine 143 lb., and vacuum, 24.5 in. An analysis of the trials gives the following values for distribution of power at the maximum speed: Indicated horse power, 2,181, apportioned thus: Initial friction, 97; load friction, 146; friction and resistance of propeller, 503; wake-gain and thrust deduction, 214; skin resistance, 539; wave-making resistance, 682. The method of working up the results of the trials is gone into in detail, showing the mathematical formulæ employed and their application, and analyses of the trials, both numerical and graphic, are included.

DISCUSSION.

Prof. William F. Durand was called on by the Chair, and he said by way of comment: "When we have a body of data relating to one specific investigation, presented in the degree of fulness that this is, so that we may be able to use it for any purpose for which such a data may be used, it is a distinct and definite advantage. Beyond this, in regard to the matter of the analysis of this data there are only one or two points that I will briefly refer to. One of the chief points made out by this mode of analysis is the determination of the wake factor. From my own studies of this matter, both by this method and by another somewhat similar method, slightly differing in detail, I have always felt that it was difficult to satisfactorily determine this wake factor, simply due to the nature of the relationship between the quantities involved. They are involved in such a way that to work backward from the power is necessarily a somewhat delicate task. We cannot help that. It is in the very nature of the case. I most heartily agree with the sentiment expressed by the author of the paper that we should hope for more definite data—better information on this point from actual direct experiments rather than by working backward from the data derived from a progressive trial. This seems to be due to the fact that a considerable variation in this wake factor only leads to a rather moderate variation in the performance of the propeller; while, *vice versa*, a moderate difference in the perform-

ance of the latter may involve a relatively large disturbance of the wake value. This has its compensation, of course, in practical designs, due to the fact that we may make a moderate error in our treatment of the wake without very seriously endangering the final efficiency of our propelling apparatus.

"In regard to the assumption that the thrust deduction and the wake return are equal, I quite agree with the author of the paper that in the light of our present experience we cannot do better, perhaps, than to accept this as a temporary adjustment. We have no right to assume, and of course we do not assume, that they are fundamentally equal or that there is any particular reason why they should be. In the light of the present data that is before us it is a very difficult matter to determine the difference between them, and, simply, while we are waiting for direct experimental investigation covering a wide range of value, we cannot do better than temporarily assume that this difference may be omitted, feeling sure that it is undoubtedly less than the necessary error of observation as pointed out by the author of the paper. We of course are not going to be satisfied with this as a final view. We must simply wait until direct experiment, and not the indirect analysis which results from progressive trials, shall provide us with something more satisfactory."

Chairman W. M. McFarland: "It is a pretty difficult thing I know for people who are engaged in the actual work of building to discuss a paper like this; so that I am sure the author will not feel slighted, because many members do not get up immediately and discuss it. I have felt myself that the value of such papers is underrated. Persons engaged in the hard work of the profession sometimes think that all these mathematics 'don't amount to anything,' but, as a matter of fact, they do. There are always some men who combine the mathematician and designing engineer to such an extent that they can make good use of this research."

TACTICAL CONSIDERATIONS INVOLVED IN TORPEDO BOAT DESIGN.

BY LT. A. P. NIBLACK, U. S. N.

In introducing his subject the author refers to the extension of the facilities for torpedo boat construction both at home and abroad. Formerly this work was confined to a few specialists, whereas now "almost any shipyard" is prepared to construct such vessels, and this naturally has caused diversity in methods and types. The individuality, not only of torpedo boats but torpedoes, makes it imperative that much practice be had with any given boat and torpedo to insure the effect of hitting. The most effective torpedo for boat use today is a 16 ft. long, 18 in. dia., carrying an explosive charge of 110 lb. gun cotton. A maximum air pressure in the flasks of 1,500 lb. per sq. in. gives speeds ranging from 30 knots for 400 yards to 26 knots for 1,000 yards. Much diversity exists in sizes, shapes and destructive capacity. "The torpedo is not a delicate instrument," the author declares, recent improvements having carried it out of this classification and given it a "secure and permanent place in naval warfare." The paper now refers to the application of the principle of the gyroscope, to the steering rudders of the torpedo, and to improvements in launching torpedoes under water from moving vessels. The former first made use of in the Howell American torpedo, as the source of power, was later applied as an attachment to the Whitehead torpedo by the Austrian Navy. This gear, in the opinion of a U. S. naval commission, "improved the performance of the torpedo 100 per cent." Further improvement, the author believes, will give an effective range of 800 yards, instead of the present limit of 500 yards. Attention is next called to the necessity of making torpedo attacks in groups of boats, a single boat only attacking as a forlorn hope—a matter lost sight of in the United States. An attack, to have a reasonable chance, must be a surprise; hence darkness, fog, mist, snow and rain are favoring conditions. In approaching to attack causes of alarm to be avoided are: White wave bows, smoke, flame, and the hum of machinery. When discovered or within striking distance high speed is important, but is not instantly obtainable. "As between 20 and 30 knots speed the time to cover 1,000 yards is only as 90 to 60 seconds—can the 30-knot boat pass from 20 to 30 knots in 30 seconds?" If three 22-knot boats cost only as much as one 30-knot, and increased numbers increase chances of successful attack, is it not wise to forego phenomenal speed? "The craze for speed is illogical and tactically indefensible; * * * * people who handle torpedo boats have never sanctioned it." What is needed, in the author's opinion, is the building of groups of boats of similar design, with standardized fittings, with a view finally to building boats in groups with interchangeable parts. As to twin screws vs. single screws, the author refers to foreign practice, in which the latter is largely adopted for boats up to 140 tons. The addition of bow rudders in the Schichau boats, for example, improved the manœuvring powers considerably. Advantages of the single screw type included: Saving in machine weight and space; fewer moving parts, therefore less chance of breakdown; smaller crew; saving in oil effected. One drawback, however, was the necessity of relatively great draft. Details are given of the system adopted in Germany, where boats are built in groups, of like design, with interchangeable parts. Reserve boats are always kept ready for service, in the water, except when undergoing repairs. In winter they are kept at a uniform temperature by steam coils with shore connections. In Germany and Italy fuel oil has been extensively used, and experimentally in Russia. "This country, of all others, might well adopt liquid fuel." Its comparative efficiency as compared with coal is as 2.27 to 1. For the same stowage it adds 60 per cent. to the radius of action of a boat. The compressed air system of feeding is to be preferred—an air compressor must be carried, anyway, and the steam jet wastes fresh water. The capacity of distillers and tanks of a boat is of vital importance. Desirable characteristics for a first-class seagoing torpedo boat are: Smallness of target; small bow wave; minimum of noise, and no flame or smoke from stacks; large fresh water capacity, tanks and distillers; reasonable bunker capacity, designed for future use of liquid fuel; habitability, well considered; moderate, reliable sea speed without forcing. A speed of 22-23 knots on 110 tons maximum displacement for sea-going class, and 45 tons' displacement for harbor defense type is recommended, and the *Morris* and *Talbot* are named as ap-

proaching the ideal in the respective classes. Since 1893 the size of torpedo boats has increased very considerable. Every effort should be made to get the torpedo boat out of the "refined machine" category—"cavalry do not use race horses." To be in accord with modern tactical and strategical ideas we need: Sea-going boats for coast defense, second-class boats for harbor defense, and torpedo boat destroyers to operate from a fleet as a base.

In the absence of the author who is on duty in the Philippine Islands the paper was read by title.

DISCUSSION.

CHARLES P. WETHERBEE had read the paper very carefully and regretted that the author was not present to answer questions. The author at the outset had apparently given the preference to the single screw boat, and yet at the close of his paper had referred to the *Morris* as the ideal type of boat for moderate speed—yet the *Morris* is a twin-screw boat. Continuing, the speaker said:

"Lieutenant Niblack evidently calls for 22 knots, and he speaks in this paper as if he expected that a boat built to go 22 knots could steal up on an enemy at that speed without any difficulty. I have had some experience in both designing and running boats of that type, and when you are running a boat that is designed for 22 knots there won't be much creeping up. (Laughter.) I think the policy that probably would be the most satisfactory, if he wants a 22 knot boat for actual service, is to call for about 25 or 26 knots from the contractor, and that will give him a boat which will go very nicely at 22 knots, because you are not going to have a boat in an emergency that you can bring up to actual trial speed. If you have a 25 knot boat from the contractor she will not flame at the stack and will not give any bad bow wave at 22 knots. Everybody knows that a bow wave is a very bad feature. I have been connected with a 30 knot boat and have found that we could only steam along at 22 knots all day with the stoke-hole open, and she will do 25 knots with any kind of dirt you put in her and not flame at the stack at all."

JOHN PLATT was called upon by the Chair, and in response said that the whole development had been toward a very much larger boat, and he believed that in England for the last four years no torpedo boats were built at all; or, if any had been built, it was only to replace boats of an earlier type. The whole disposition was to build a much larger boat, which is a torpedo boat and capable of high speed and is satisfactory at sea. He referred to the statement of Mr. Wetherbee, which he took to mean that a 30-knot boat could not reach that speed without flaming at the stacks, and such. Taking the conditions imposed in the British Navy, this was not so. There the boats had to make their speed on a given coal consumption with a given load—a consumption not more than 2 1-2 lb. per horse power. It was not possible to get below 2 1-2 lb. and have flaming at the stacks. These onerous trial conditions had the effect of producing boats that could reach their speed under fairly economical conditions, provided, of course, that the bottom was clean and that the screw propellers were correctly designed. The falling off in speed, however, under any conditions should not be more than two knots.

GEORGE W. DICKIE, who was asked for an expression, said he was out of the torpedo boat business. "At last year's meeting of this Society I presented a torpedo boat," he continued. "She made a trip across the Atlantic; she was seized there by a Scotchman, and he took the Thornycroft boilers out of her and put in Scotch boilers. He sent her to the Institution of Naval Architects and she was there dismantled. Since then I have lost a great deal of interest I had in this question. I think, however, that if that class of boat is built at all they must be built so that they can go to sea and stay at sea, and make a sea voyage when they are wanted to without waiting for weather conditions, and that they should be able to accompany a fleet wherever that fleet should be sent. While we have been modifying the boats —it is the torpedo boat destroyers I am thinking of just now— in this country, and the latest ones have been improved very materially, I think that there is a wide field to go on in the same direction, so that we can have torpedo boats in which officers and crew can live comfortably, that they can feel at home in, and that they can be ready whenever they are ordered to go where they are wanted, and in any kind of weather."

MR. KEMBLE believed that it would be wise to sacrifice some speed for protection, say, a drop from 28 to 24 1-2 knots actual sea speed; and this would allow a 1-2 in. nickel steel protective deck, thereby increasing the confidence of the personnel, and greatly increasing the ability of the boat to deliver her attack.

JOHN C. KAFER pointed out that the *Furor* and *Terror* as boats which in actual service fell far short of their reported trial speeds. He agreed with Mr. Dickie that what was required was a boat that would give speed whenever it was needed.

JOHN PLATT said the *Farragut*, built by the Union Iron Works, similar to a British boat, had given 31 1-4 knots on trial for a considerable length of time, and that this speed was never attained by a similar boat in England.

MR. WETHERBEE said his experience was, that, owing to inexperience, we could not get as much in the way of speed out of boats as foreigners did—they had the advantage of a very experienced personnel. In the matter of speed reduction he did not mean that a naval crew could not get within four knots of trial speed, but that if the Government would contract for a high speed they would get a boat that would go along very easily at, say, three or four knots less. As to the size of screw there was much opposition here to a considerable draft of water in a boat, caused by the need for our boats to pass through canals. A single screw boat, such as referred to by Lt. Niblack, would need a draft of about 8 ft. in order to get a decently efficient propeller.

NAVAL CONSTRUCTOR W. L. CAPPS believed a commanding officer would hesitate to force his boat up to a 30-knot gait, for fear of a smash-up. There was room for development along the line of increased strength of parts, and two types of boats would be useful—one 100 tons and the other about 500 tons. The larger boat would be strongly built, and would have large capacity for fuel and water.

CAPTAIN CHARLES L. OTTLEY, R. N., presented some views gathered from the work of torpedo boat destroyers on the coast of Crete, in the Mediterranean, during the blockade: "As Mr. Dickie said just now, what is desired is to have a class of boat which shall be able to accompany fleets, and act with fleets. On the Cretan

blockade we brought our destroyers up from Malta. We kept them on that coast. The coast of Crete in wintertime is very nasty. Sometimes, especially on the northern coast, gales of wind come up suddenly. Our torpedo boat destroyers were there pretty constantly, and were of the greatest possible use. Of that there is no question. They were extremely useful in carrying messages from the bigger ships up and down that coast. What I wanted to say was that they practically wore themselves out over that business. I assure you that whatever may be done in times to come, any officer who has had anything to do with those boats in actual war conditions, or conditions nearly approaching to it, as it was then, will tell you the same thing. The captains of those boats absolutely wore their boats to pieces. The boiler tubes gave out. A boat would be brought into Canea Bay and the machinery patched up, and out she would go again. I think we are far from having got hold of a design of torpedo boat destroyer which can be said to accompany fleets any long distance. I think our policy in England is that the type of destroyers should act in the narrow seas, should be at the nearest points, and that a telegram can be sent to that point to a torpedo boat: 'Your objective will be at sea at such and such a point.' But at present torpedo boat destroyers are not much further on than that.

"Then there was one other point, and that is the question whether by reducing speed you could take some of the weight so gained and put it on in the form of armor plating. The armament of a torpedo boat destroyer consists, usually, of somewhere about half a dozen 6-pounders and one 12-pounder. I remember being one of a number who were in favor of putting in a bigger gun. We were asked: 'What do you want to put a 12-pounder in there for? A 6-pounder will go through any torpedo boat.' The answer was, that from actual practical experience it was found that a 6-pounder would go through the side all right, but would not vitally damage the machinery or the boilers. The boiler of the boat was so thick that nothing but a 12-pounder would go through it. You see a 12-pounder would go through a good deal more than half an inch of nickel steel. It means you have got to protect your boats so heavily to protect against the 12-pounders that I am afraid you would lose in speed considerably."

Chairman W. M. McFarland, at the close of the discussion, said the torpedo boat was in an unfortunate condition—it was wanted to do such an infinite variety of things. One wanted to drive it as fast as possible; another wanted to use it for a despatch boat—a combination of racehorse and roadster. The troubles referred to by Captain Ottley at Crete were similar to those experienced by our Navy on the coast of Cuba. Torpedo boats were used as despatch boats in all sorts of weather. On one occasion, he was informed, the *Ericsson* come in from twenty-four hours' despatch duty in very rough seas. She tied up to the dock, and immediately the officers fell down asleep on deck at the stern, and the men fell down asleep at the bow. It was not much wonder that things got out of order used in that way.

ON THE ACTION OF THE RUDDER.

BY PROF. W. F. DURAND.

The author prefaces his paper with the statement that "our knowledge of the forces which act on the rudder is dependent almost entirely on a few scattered experiments on widely separated types of ships." An estimate of these forces is necessary in the design of the rudder and attachments, more especially of the steering engine or motor, both in regard to the power which it must develop and the moment which it must be able to exert on the rudder stock. The available data is insufficient to furnish any satisfactory empirical theory, though an incomplete theory has been widely adopted, based on Joessel's experiments which give the forces acting on a plane placed oblique to a moving stream. In the paper the formulæ resulting from the application of the results of the Joessel experiments to the case of the rudder are given in detail, and are discussed in various ways. The chief difficulty in making direct application of these results lies in the fact that the angle between the rudder and the flow of the stream in which it moves is not equal to the helm angle, but is less by some unknown and variable amount. This reduction, the author shows, is due to the sidling motion of the ship, moving under the influence of the rudder, in consequence of which the inclination of the rudder to the line of flow at the stern is less than its inclination to the keel. For this reason the use of the helm angle in formulæ derived from the Joessel experiments gives forces much larger than those obtained by observation. The ratio between the actual force ascertained by experiment and the value derived from formula is termed the "coefficient of reduction." Recorded trial data for the purpose of such determination is limited to less than a dozen different cases, and an abstract of these is given in the paper. In the absence of such data the author suggests that for purposes of design the forces may be approximated to by the use of the formulæ referred to and by the assumption of what may seem to be a suitable coefficient of reduction. If the characteristics of the motion of the ship while the helm is being put over could be determined, the extent of the reduction in the obliquity of flow—due to the sidling motion of the stern—could be found and an approximation made to the value of the coefficient of reduction for that particular case. To map out these characteristics, however, would require the use of equations so numerous and so related that "they seem to defy all attempts at analytical solution." The author, therefore, supplies a special method for the treatment of differential equations of this character, so that a very close approximation can be reached in any given case. To illustrate this the case of a vessel of 8,000 tons' displacement is worked out in the paper, and details of the movements of the vessel during the period while the helm is being put over are shown graphically. From the work accomplished several deductions are drawn by the author. "The reduction of forces will be greater, as the rudder is larger relatively to the size of the ship, as the speed with which the helm is put over is less, as the speed of the ship is greater, and as the ship itself is smaller, while the reduction will be less under opposite conditions. * * * * * The reduction in speed during the time necessary to put the helm over is quite inconsiderable." In closing, the author refers to the limitations of purely mathematical treatment, "for only as experimental values are available to furnish a constant control over the abstract relation are analyt-

ical methods of practical value." He makes an earnest plea for further experiments, especially at speeds of 20 to 30 knots.

DISCUSSION.

Prof. Cecil H. Peabody, in response to a call from the Chair, said in discussion: "It appears to me that the paper itself and the explanation of it which has been made by the author are such as to require very little in the way of general statement. Of course, a complete discussion of this will go into theoretical and mathematical work in a manner which might not be necessary or desirable now. It does, however, seem to me that a thing might be said that the author might hesitate to say for himself. It is clear enough that the experimental work on which this is based is incomplete, and to an extent unsatisfactory; that the comparison of the experiment is more unsatisfactory, as referring to only isolated tests, and a few of them, and it would occur to us to ask why all of this work should be done. It is not pointed out by the author that he has given us some tools which will be ready when we have a chance to use them. Even though the entire set of equations here shall need to be re-cast the methods remain, and that is a distinct addition to our knowledge."

George W. Dickie wondered whether, "if we knew exactly how many foot pounds were required to bring a rudder over, under certain conditions of speed, and certain area of rudder, whether we would reduce the size of our hydraulic cylinders or our steam cylinders for operating rudders?" He had no recollection of any gear that would not bring the rudder over—they seemed to be on the safe side all the time. Three or four sizes of steering gear generally carried the builder through all the range of ships that were built.

F. L. Du Bosque inquired whether any consideration was given, in the paper, to the shape of the ship in calculating the effective effort of the rudder. It was a common experience with those who had to do with canal boats to find that they required a rudder about three times as large as a finely formed boat of the same length.

William F. Durand, replying to the query of Mr. Du Bosque, said the equations given provided for the introduction of the feature referred to; but engineering judgment was demanded in the application of the equations to any given case, so that the necessary corrections for differences of form could be made. As to the remarks of Mr. Dickie, the speaker had pointed out in his paper that these matters could be considered from two standpoints—the strength of the parts and the capacity of the motor. With regard to the first-named this refinement could not enter into the question. Experiment had shown that, due to the action of the waves and other causes, stresses three times the normal were likely to occur at any moment, and it was necessary in designing the rudder stock and other parts to employ a large factor of safety. As to the capacity of the controlling motor, however, it might be more justifiable to proportion the motor to what might be termed the "average resistance," rather than to the exceptional. This was a matter for the designer, and in this investigation the speaker had satisfied himself with an effort to provide an instrument of examination and research.

CLOSE OF THE MEETING.

This discussion closed the technical sessions, and the customary votes of thanks to the Presiding Officer and the Secretary were passed with great heartiness. On motion of John Kafer, the Chairman announced the seventh general meeting adjourned.

Obituary.

With the death of William H. Webb, shipbuilder, which occurred October 30 last, the dean of the profession in America has passed away. The great name and fame of the deceased as a builder of ships was world-wide long before the present generation took any interest in vessel construction. Mr. Webb was born in 1816, in New York, of New England stock. He early engaged in shipbuilding, and more than half a century ago he had the design of some of the fastest clippers of the day to his credit. During the many years of his active professional life he designed and built more than 150 vessels of all classes in his yard at Sixth street, on the East River, New York. These included every variety of merchant vessel, sailing ship, sound steamer, ocean liner and smaller craft, and also many powerful war vessels for foreign governments. His masterpiece, perhaps, was the war vessel *Dunderberg*, sold to France and long retained on the active list of that nation. This was a steam screw vessel, and in her construction were embodied many improvements that in later days have been put forward by others as novelties. Since his retirement from active professional life Mr. Webb had devoted himself largely to charitable work. Much of this was done so privately that few knew its extent. His most public act was the establishment of the home for indigent shipbuilders and for the technical education of young men, without charge, at Fordham Heights, New York City. This institution, widely known as Webb's Academy and Home, was described in a recent issue. Deceased left a large fortune.

General Thomas W. Hyde, shipbuilder and principal owner in the Bath Iron Works, Bath, Me., died November 14, at Old Point Comfort, where he had gone for his health. He was born in Italy in 1841, and he was educated at Maine schools, later at Bowdoin College, and completed his studies at Chicago University. Soon afterward he received a commission in a Maine Regiment and served with distinction during the Civil War, being granted a special medal for bravery by Congress. After the war he returned to Bath, Me., and entered the iron business, first with the Bath Foundry, and later with the Bath Iron works. General Hyde took an active part in state politics, and served several terms in the State Senate. He had a very wide circle of both business and personal friends, who hold his memory in high esteem.

A report has been made by the U. S. Naval Board upon the Holland submarine torpedo boat, and this is now under the consideration of the Board of Construction. Chief Engineer John Lowe has reported favorably on the boat, and urged the construction of a number of these boats for harbor defense.

It is planned to hold an International Congress of Naval Architects and Constructors under the auspices of the French Government at the 1900 Exposition in Paris. Those who desire to participate are requested to communicate with M. Hauser, Secretary, 4 Rue Meissonier, Paris, France. All papers must be in before June 1, next.

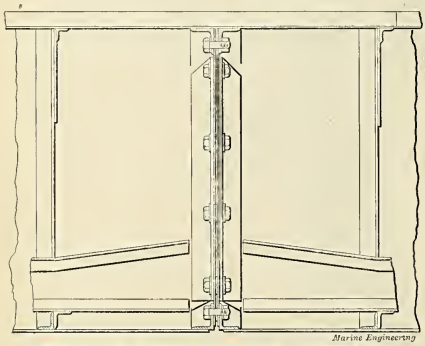
WHITE STAR LINER BRITANNIC, IN SERVICE AS BRITISH TRANSPORT, LEAVING QUEENSTOWN WITH ROYAL IRISH RIFLES, FOR SERVICE IN SOUTH AFRICAN CAMPAIGN.

Many of our readers will recognize the steamer in the foreground of the accompanying photograph, the famous old transatlantic White Star liner *Britannic*. She is now in the service of the British Government carrying troops to South Africa, and is officially labeled "Transport No. 62." In the view she is starting from the mail steamer wharf at Queenstown on her 6,000 mile voyage to the Cape of Good Hope, and just beyond her the port guard ship lies at anchor. The South African war has caused the temporary removal of many vessels in the transatlantic trade, and has had a serious effect on ocean freights. In modern times no transfer of troops by sea has been of such magnitude. To date, transportation for about 50,000 men, with all the necessary equipment of horses, guns, munitions of war, and stores of every conceivable description, has been provided. About 150 vessels have been engaged for the work, ranging from the freighter of 1,500 tons up to the magnificent White Star liner *Majestic*, and the total tonnage is about 700,000 tons. Two of the regular mail steamship lines connecting England and the Cape—the Castle line and the Union line—own considerable fleets of large and full-powered vessels, and these, of course, were made use of extensively by the British Government, and they formed the nucleus of the transport fleet. From the transatlantic service a large number of vessels were drawn. Seven of the Cunard boats were chartered, including the *Servia* and *Aurania*. The Anchor line furnished three, including the *City of Rome*, and the White Star line two mail steamers and two freighters. Other well-known vessels chartered are the National liner *America*, Atlantic Transport liner *Mohawk*, Furness, Withy & Co.'s *Rapidan*, Leyland line S. S. *American*, Dominion liner *Englishman* and Allan liner *Bavarian*, and others. The average size of vessel is nearly 5,000 tons.

SHALLOW DRAFT STERN WHEEL STEAMERS AND BARGES FOR MEXICAN GOVERNMENT.

One of the evidences of the present boom in shipbuilding is the spreading out of this art into territory which, in recent times at least, has not been included in the shipbuilding statistics. A case in point is the construction of a fleet of five stern wheel steamers and twenty lighters, on order from the Mexican Government, by the Johnson Iron Works, located at Algiers, La., but within the corporate limits of New Orleans.

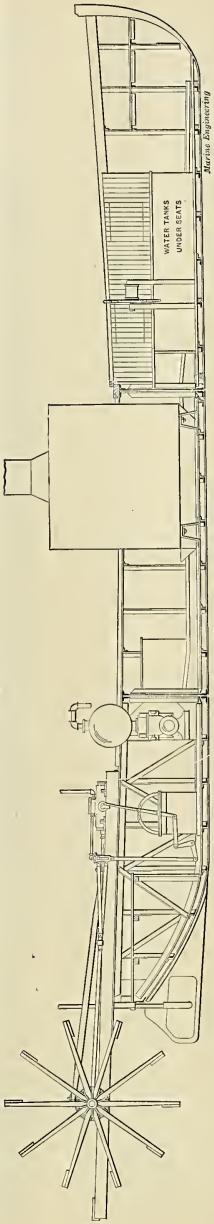
In the accompanying engraving we show these interesting little vessels in various positions when completed and ready for shipment by steamer to their destination. They were all built of steel, each in sections dividing the length into three parts. In dimensions the steamers are as follows: Length, 34 ft.; maximum beam, 10 ft.; depth, 3 ft. The lighters are of similar dimensions as regards length and depth, but are of 1 ft. greater beam. The steamers were built of 3-16 in. plate throughout and the lighters of 3-16 in. plate and No. 8 plate.



ENLARGED SECTION THROUGH BULKHEADS.
DETAILS OF SECTIONAL VESSELS.

The rivets were 3-8 in. and were all driven hot, flush on the outside to countersunk rivet holes. In design the lighters have sharp bows and square knuckles, the steamers having round knuckles.

In the case of the lighters each section has a fore and aft bulkhead of No. 8 plate, and a cross bulkhead at the union of the sections, the cross bulkheads being close riveted to a 3 by 2 1-2 in. angle frame with welded corners. These welded frames carry a series of holes for 3-4 in. screw bolts, spaced on the bottom and sides 4 in. between centers, so that the sections are readily bolted together through these frames. An angle 3 by 2 in. runs across the top of the bulkhead plates and is securely riveted to them. The fore and aft bulkheads are fastened to double 2 1-2 in. angles riveted to the cross bulkheads at their centers. Holes for 3-4 in. bolts, spaced 8 in. between centers, are drilled through the top angles of the cross bulkhead plates and through the 2 1-2 in. vertical angles of the fore and aft bulkheads. The top edges of the plates of the lighters are finished with a 2 1-2 in. angle riveted in place and terminating at the end of each section length. A gusset



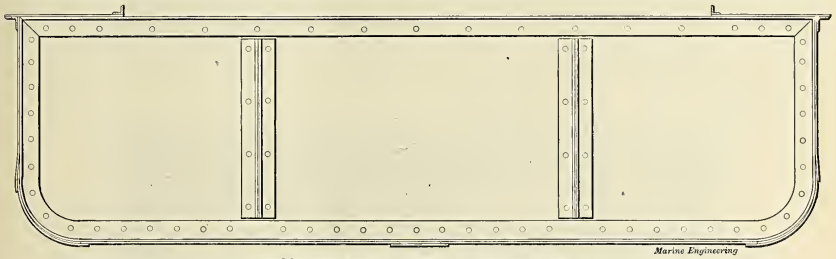
LONGITUDINAL SECTION.
STERN WHEEL LIGHT DRAFT RIVER STEAMER, FOR MEXICAN GOVERNMENT, BUILT AND ENGINED BY JOHNSON IRON WORKS, NEW ORLEANS, LA.

plate lapping the contiguous fore and aft angles, and the cross bulkhead angles on their top sides will be riveted in place when the lighters are finally put together at their destination.

A similar method of joining the sections together has been adopted in the case of the steamers. These latter

speed of nearly 7 miles per hour, and with a lighter in tow containing 60 men, a speed of 5 3-4 miles was attained.

The carrying out of this contract successfully is very creditable to the enterprise and skill of this establishment. When the contract was made, March 29 last,

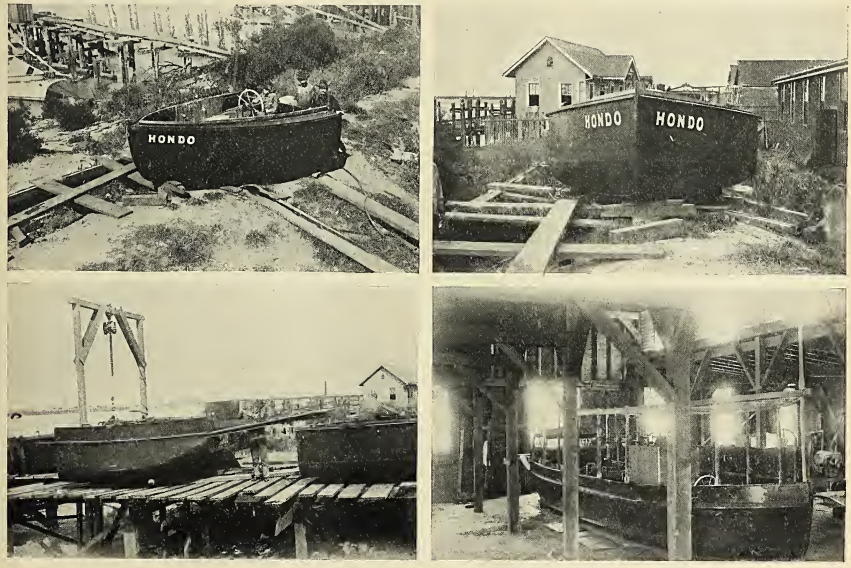


CROSS SECTION AT BULKHEAD FRAME.

DETAILS OF FRAMING AND PLATING OF LIGHT DRAFT RIVER VESSELS.

are equipped each with a Roberts water-tube boiler built for 200 lbs. working pressure, and stern wheel engines, with cylinders 4 in. dia. and 16 in. stroke, fitted with balanced slide valves. The stern wheel is 6 ft. dia., and is fitted with buckets 6 ft. long, and when running

there was no equipment on the ground suitable for turning out this class of work. A building was speedily put up, however, and meanwhile the necessary tools and apparatus were purchased and installed. Steam was raised in the new shop and the actual work of con-



PHOTOGRAPHS OF SECTIONAL RIVER STEAMERS FOR THE MEXICAN GOVERNMENT.

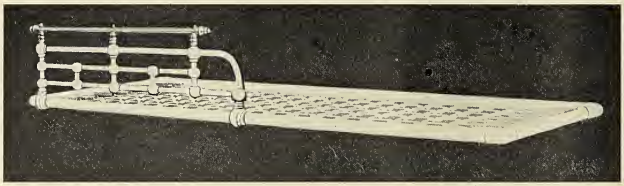
loaded the engines will turn at 39 revolutions per minute. Each steamer is equipped with an independent combined surface condenser and air pump of sufficient capacity to maintain 26 in. of vacuum on trial. On trials for speed, in slack water, the steamers attained a

struction commenced about the middle of May. Serious delay was experienced in the delivery of material, but in spite of this the entire contract was completed within the guaranteed time and the vessels were all ready for delivery early in September.

IMPROVED APPARATUS.

Metallic Steamer Berth.

An improved form of metallic steamer berth is shown in the illustration of a standard berth made by the Hartford Woven Wire Mattress Co., Hartford, Conn. This is composed wholly of wrought iron and malleable castings, with steel netting for bed bottom, and fine quality oil-tempered helical springs at the ends of the netting. The springs are attached to the frame by a series of hooks on the ends that are counter sunk into the wrought iron and riveted down, making a smooth finish on the end. The frame is composed of wrought iron tubing 1 3-8 in. outside dia., and the sides of the same material; the outer band of 5-8 in. and the filling of 1-2 in. material. The top bar is of brass either nickel plated or lacquered. As required, the berth is made to fold up or remain open permanently. Among the advantages claimed for it are that it is aseptic and vermin proof. If desired the berth is supplied with an attachment which can be screwed to the joiner work making it a permanent fastening without any other casing being required.



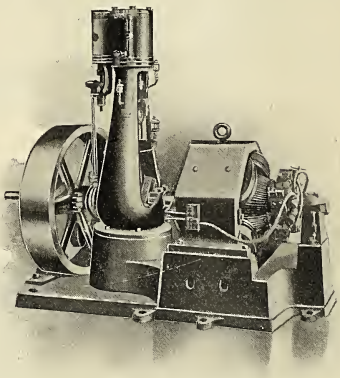
HARTFORD WOVEN WIRE STEAMER BERTH

Racine Automatic Engines.

Our engraving shows a direct connected lighting set in which motive power is provided by a Racine automatic high speed engine. This is a specialty of the builders who manufacture a range of sizes from 2 to 37 horse power. The engine is compact in design, having a self-contained base which provides a rigid foundation for both engine and outbearing, so that the latter cannot get out of line. The frame is rigid and of neat appearance, and in process of manufacture the cross-head guides, the frame faces, and crank shaft boxes are machined at one setting, insuring accuracy of alignment. A piston valve is employed, the clearance spaces being reduced to a minimum. The connecting rod is a flat steel forging, and the crank pin boxes and small end bushing are composed of a special alloy. Charcoal iron is used for the cross-head with shoes of special bearing metal and the pin is of hollow steel, with oil holes in the top surface, the pin and bushings being lubricated from a convenient end oil cup. A Rites patent fly wheel governor is fitted and is guaranteed to regulate within 1 1-2 per cent from no load to full load. The center crank is a solid steel forging and is fitted with automatic lubricator. The engine, with cylinder 7 in. by 7 in. and turning 350 revolutions at 85 lbs. boiler pressure, cutting off at quarter stroke, is rated at 17 horse power. With two pulleys it occupies 34 in. by 49 in. floor space, and measures 5 ft. 4 in. in height. The shipping weight is 1,650 lbs. The manufacturers are the Racine Hardware Co., Racine, Wis.

Pneumatic Reversible Boring Machine.

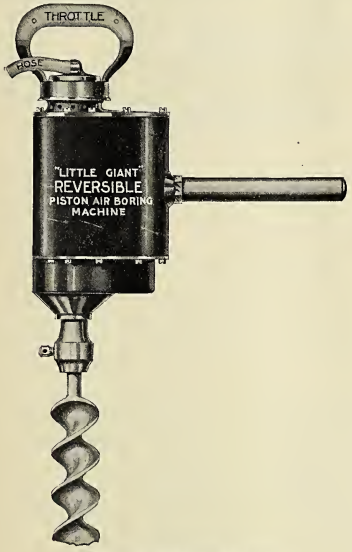
A new portable tool known as the "Little Giant" pneumatic reversible boring machine has been brought out by the Standard Pneumatic Tool Co., Marquette Building, Chicago. This is similar in construction to the regular No. 2 boring machine of this Company, but possesses in addition a means of reversing the direction of the boring bit or augur when the machine is running at full speed. This is accomplished, so far as the operator is concerned, by the simple turning of a small lever, and it permits of the ready withdrawal of the augur. No gears are used in connection with the reversible attachment. For this machine, the makers claim advantages of light weight, compactness, and economy in the use of air. It is so fashioned as to be easily operated very close to a corner, and is especially adapted for use in shipyards, dock construction, and other places where much heavy work is to be done. The machines are sent on trial and guaranteed against repair for a year.



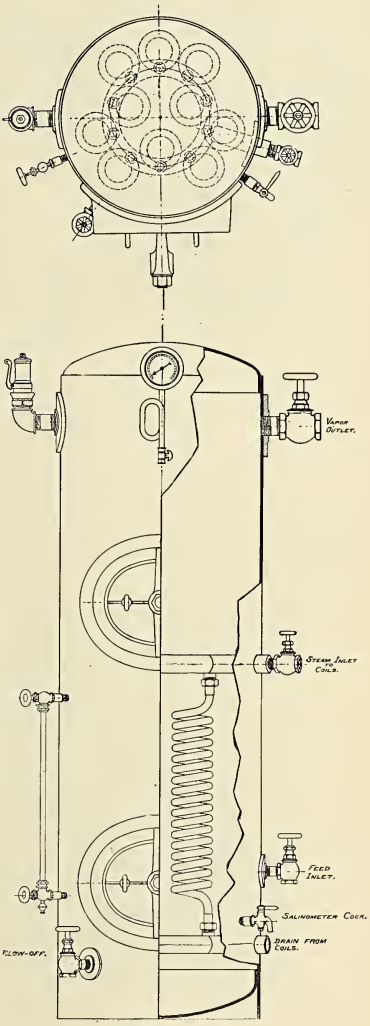
RACINE GENERATING SET.

Quiggin's Patent Evaporator.

The necessity of having aboard sea going vessels the means whereby fresh water can be produced, was demonstrated during the late war with Spain, when many vessels were suddenly called away to ports where fresh water was a scarcity. An exaporating plant aboard a vessel greatly increases the vessel's radius of action. The Quiggin's patent evaporator, illustrated here, has met with marked success since its introduction in the marine trade. It has been fitted in some of the largest American transatlantic lines and in many coastwise vessels, yachts and also in the U. S. Revenue Cutter Service. It has been exceedingly popular in England for many years and has been widely adopted by the British Admiralty, and many of the leading lines. Special features which recommend it to the marine engineer are its lightness and its ready accessibility for cleaning. It requires no additional space for withdrawing heavy nests of coils for scaling and it also possesses the peculiar feature of making it possible to increase the capacity or heating surface by adding additional coils without taking up additional space or disturbing the apparatus in the ship. The shells are of boiler steel and have two manholes. The heating surface consists of annular-shaped composition manifolds having ground joint union connections for engaging the spiral coils. These coils are made of seamless copper tubing 7-8 in O. D. and will stand a pressure of 1,000 lbs. to the sq. in. They are grooved after coiling up in such a manner as to indent the surface and make a crescent-shaped tube the whole length of the coil. The special feature in this grooving is that the coil expands in two directions, and any scale which may be formed on the coil is quickly broken off. The ground joint unions on the ends of the coil are all interchangeable and made to a gauge. Besides being used in the marine trade, these evaporators have been employed on shore in ice-making plants, etc., for producing fresh water. They are manufactured by the James Reilly Repair & Supply Co., of 229-230 West street, New York city.



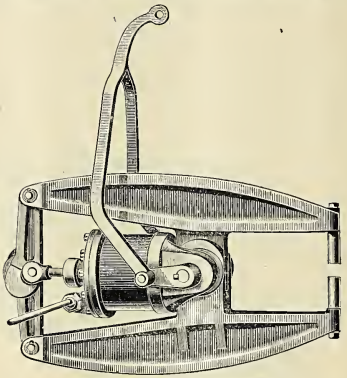
PNEUMATIC REVERSIBLE BORER.



QUIGGIN'S EVAPORATOR.

Portable Alligator Riveters.

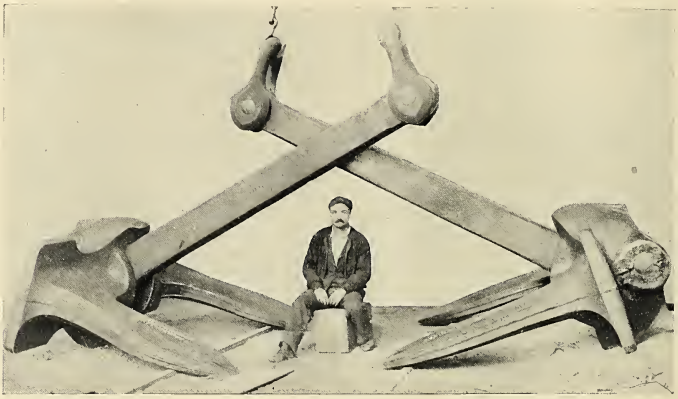
Riveters of the squeezer type which operate by direct pressure and not by a succession of light hammer blows are built by the Bethlehem Foundry and Machine Co., of South Bethlehem, Pa. A good example of this type of riveter is shown in the engraving herewith of the portable alligator riveter, operated by compressed air, which is made by this company. This riveter is 5 ft. long, weighs 1,500 lbs., and has 20 in. reach at the center of the jaw and 3 1-2 in. stroke of dolly bar. The pressure cylinder is 12 in. dia. and 9 in. stroke. With the exception of the cylinder and a few minor parts the machine is made of steel castings and forgings, and is well balanced, easily handled, and is guaranteed to drive any size of rivet in common use. With a gang of four boys a record of 3,000 3-4 in. rivets in ten hours is claimed for this machine, the conditions being favorable for speed. Air pressure of 60 to 80 lbs. is usually employed with this machine, about 5 cu. ft. of free air being required for each rivet driven. At a speed of 3,000 rivets a day of ten hours, 15,000 cu. ft. of free air would be required. The makers figure that allowing for loss by leakage, etc., about 20,000 to 25,000 cu. ft. of free air would be necessary, and on this basis 40 cu. ft. of free air per minute would be required. Assuming one horse power to be capable of reducing 5 cu. ft. of free air per minute to a pressure of 75 lbs. per sq. in., the service would call for 8 horse power at the compressor.



PORTABLE ALLIGATOR RIVETER.

Baldt Stockless Anchors.

A comparison between the size of the man and that of the anchors in the accompanying reproduction of a photograph will convey an idea of their actual size. These two anchors were manufactured by the Baldt Anchor Co., of Chester, Pa., for the equipment of the U. S. Army transport *Thomas* engaged in carrying troops to Manila. The pair weigh 27,000 lbs., and are the largest stockless anchors ever made in this country. On October 11 the order for these anchors was placed by the Government through the James Reilly Repair and Supply Co., of New York, and work was so rushed that they were turned out at the steel works on October 28, and were put aboard the transport at Brooklyn, November 1 last. Open hearth steel, 60,000 to 70,000 lbs. T.S., with elongation 15 to 25 per cent in 8 in., is the material used. Severe physical and chemical tests were also imposed. This type of anchor has been approved by Lloyd's Register, the Bureau Veritas, and is in use on naval vessels.



BALDT STOCKLESS ANCHORS FOR U. S. TRANSPORT THOMAS.

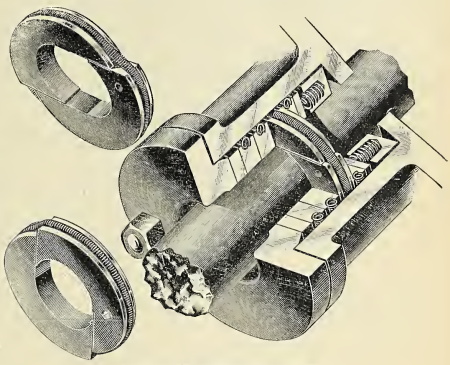
Harthan's Metallic Packing.

"Use good judgment and a little cylinder oil" are the directions for applying Harthan's metallic rod packing given by the manufacturers. This is a genuine metallic packing which has been in use for a considerable time on land engines and has recently been adapted for use on board ship. It is designed so that it will fit any fiber-packed stuffing box, and it can be put in place or

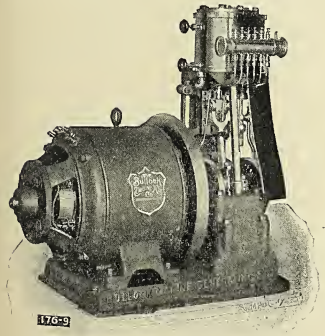
removed without disconnecting the rod from the cross-head. As shown in the engraving printed herewith the packing does not project down below the usual depth of the stuffing box and gland. The split rings are made of a special composition that will not run when an engine is working and at the same time is not sufficiently hard to score the rods, and these rings are held in place by coil springs. This packing can also be readily applied to valve rods. It is manufactured by the Reeves Machine Co., Trenton, N. J.

Bullock Generator—Forbes Engine.

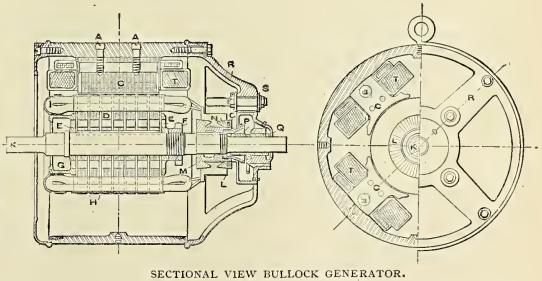
The combination electric generating set illustrated in perspective here consists of a Bullock type of generator direct connected to a Forbes marine engine. The engine cylinder is 5 in. by 5 in., built for high pressure steam. The cylinder is supported upon steel legs fastened to a subbase common to both engine and generator. To two of these supports the cross-head guide is securely bolted. Means are provided to adjust for wear of the cross-head shoe and guide and in the main bearings. A perfect system of sight feed lubricators is installed with copper tubes leading to all of the wearing surfaces of the engine. A small balance wheel is provided and assists in the regulation of the engine speed. The governor is of the inertia-centrifugal type and maintains a speed between no load and all load limits of less than two per cent variation. The valve is of the cylindrical balanced type and gives a perfect steam distribution. The generator is very compact, pleasing in outline and presents some interesting features of design as will be seen by consulting the sectional engraving. The yoke is a steel casting of circular form having inwardly projecting pole pieces of laminated soft steel. Each pole is bolted to the frame by two bolts *A-A*, the centrally located rivet *B*, of the laminated pole *C*, being tapped and serving as a nut for the bolts. The armature core *D* is built up of laminated soft steel mounted directly upon the shaft and held firmly together by iron end plates *E* and nuts *F* as shown, one end plate resting against shoulder *G*. Ventilating slots *H* perpendicular to the shaft are provided. The windings *I* are perfectly insulated before being placed in the slots of the core. The windings are held in place by steel wire bands wound in slots making a flush finish with the outside of the laminated core. The armature shaft rests in a phosphor bronze bearing at the outer end and is keyseated in the hub of the engine fly wheel. The commutator bars, shown at *L*, are held together by sleeve *M*, ring *N* and nut *O*. Oil shield *P* prevents oil from finding its way from bearing *Q* into the armature. The bearing *Q* is of the self-oiling type as shown. The end housing *R*, securely bolted to the frame, carries the brush studs *S*. The field coils *T* are machine wound and thoroughly insulated. The engine operates at 600 R.P.M. and at this speed the capacity of the generator is 5 K.W. at 115 volts pressure. This particular set is now installed upon the steamer *Aberdeen*, a vessel recently built for the Pacific coast trade. The manufacturers are the Bullock Electric Manufacturing Co., Cincinnati, Ohio. They make a full line of sizes of these engine type generators, and have also gone extensively into the equipment of machine tools with electric motors for direct driving.



HARTHAN'S METALLIC PACKING.



BULLOCK GENERATOR—FORBES ENGINE.



SECTIONAL VIEW BULLOCK GENERATOR.

MARINE ENGINEERING

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Notice to Advertisers.

Copy for changes in advertisements must be in our hands not later than the 20th of the month to insure changes being made in the issue of the month following, and not later than the 15th of the month if corrected proof is to be submitted.

BY the time the reader has come to these pages he will have observed that this issue contains a very complete report of the proceedings of the seventh general meeting of the Society of Naval Architects and Marine Engineers, held last month in New York. From a business point of view the Society is in a very progressive condition, without debts, with a safe balance in the bank, and with a large and very rapidly increasing membership. That the financial conditions are so good bespeaks good management, for, as pointed out by President Griscom in his annual address, the dues are less than those of kindred societies. From a technical standpoint, the conditions were quite as satisfactory. The high grade of work demanded by the Society was well sustained in the papers read and discussed. The meeting did not, of course, take place without some criticism, and this was chiefly in the shape of expressions that naval matters were given attention largely to the exclusion of the mercantile marine. We believe that a fair examination of the programme will not support this criticism, for out of a total of fourteen papers, six were of as great, if not greater, importance to mercantile than to naval needs; while of the remaining eight, two papers (water-tube boiler and electrical equipment) while written entirely from naval standpoints, yet contained much that would be applicable to merchant marine practice or at least to a solution of pressing questions in that practice. In the matter of discussion, if naval men, by reason of their training and their freedom from the restrictions imposed by "trade secrets," have a preponderant share in the proceedings, it is the fault wholly and solely of the representatives of the merchant marine. Discussion from any competent person is not only welcomed but sought, and can be taken part in not only on the floor but by written communication. As a matter of fact, on several occasions while certain forms of apparatus were under discussion, well known makers of like apparatus were in the auditorium, but took no part in the debate. In this connection, too, many of the steamship owners who are members could add materially to the value of the transactions by permitting their superintending engineers to give facts and figures concerning operation, for all construction is toward the end of satisfactory operation. Speaking of discussion recalls the very pointed reply made by Engineer-in-Chief George W. Melville to the paper on the *Denver* class of cruisers prepared by Chief Constructor Philip Hichborn. Abstracts of both will be found in the preceding pages, so that we need not repeat their substance here. Reading over the Chief Constructor's paper it would not occur to us that any criticism of the neighboring Bureau of Engineering was intended, but whether or no the explanation by the Engineer-in-Chief of the causes for the *Raleigh's* trouble ought to set matters straight in all minds. It is somewhat curious to note that while the Engineer-in-Chief takes pains to explain at length the reasons for the *Raleigh's* inefficiency, with a view manifestly to shutting off unfair and outside criticism, he takes the Chief Constructor to task for defending the *Denver* designs from hostile criticism. That the design was adopted only after very careful consideration by the Board of Construction is to be expected, but that the naval experts ought to know the needs of the service and know better how to fill them than outside critics, is a statement not so readily agreed with. In the first place the needs of the navy are a matter of opinion largely, and find expression in the extreme, in the torpedo crank, the ram crank, the submarine boat crank and so on. Again there are subdivisions of enthusiasts. Take the torpedo boat, one wants it large, another small, one comparatively slow, another very fast, and so on.

Now it is reasonable to suppose that all opinions and all avenues of knowledge are not confined to the commissioned ranks of the navy, and that an outside expert by reason of his qualifications or experiences might have possession of one or two practical ideas. But aside from expertness is the liberty of speech and expression of thought, which is the inherent right of every American and the duty of those who hold the public ear, and which we believe would find no more earnest champion than the Engineer-in-Chief. And when such expression is given credence to by a wide audience, such as readers of the public press, it seems a very proper proceeding for those responsible to the people to give forth their reasons for expending the public money in ways which have been the subject of such criticism. This the Chief Constructor has done, and his arguments are convincing. We shall have six vessels, which in every respect will be a credit, alike, to all the responsible Bureaus, and which will not be white lies, but will carry the distinctive American color anywhere, at any time, at the designed speed.

FROM present indications it seems probable that the Naval shipbuilding programme which will be presented to Congress for consideration will be by no means an extravagant one. Indeed, considering the increased need for an effective naval force, which recent stirring events has brought about, and the efforts of other nations in the direction of sea power, it is a serious question whether our naval forces, present and prospective, are not inadequate. This is, however, a country governed by the people, and the development of our naval power is more dependent upon a proper knowledge of naval needs by the people than is the case with other nations of the first class. Abroad, the opinion of the "powers that be" on such matters is more generally accepted as conclusive by their countrymen than here. There seems to be a widespread belief here that at any time a powerful emergency navy could be improvised that would sail out and capture or destroy any hostile fleet. To this belief many of the uninformed though well intentioned voters are close adherents. Going a little higher in the scale of knowledge of naval affairs, many will be found who while they do not believe that tugs, yachts and coasting vessels can be converted into efficient battleships and the like, yet look to native genius, the abundance of materials, and expeditious American mechanical methods to pull us out of a hole in time of need. The first named class found their belief on such exploits as that performed by the converted yacht *Gloucester* at Santiago, and the others go back to the Civil War period of rapid construction, with Ericsson as their patron saint. Probably no one regrets more than those in authority that the modern warship is a box of complications fearfully and wonderfully made, but it is so, and so long as we have to encounter vessels of other nations so equipped we shall have to keep up or suffer the consequences. That certain modifications of existing designs are possible, which would result in simplicity, with even a gain in efficiency, is beyond question, but that is quite aside from the absurdity of "Emergency Construction." But to return to the forthcoming programme it is some satisfaction to note that it contemplates the construction of up-to-date and immediately useful types. In substance the programme is as follows:

Three armored cruisers of about 13,000 tons trial displacement: Maximum draft, 26 ft.: Heavily armored and armed: Sheathed and coppered: With the highest "practicable" speed, and great radius of action.

Three protected cruisers of about 8,000 tons displacement, carrying a powerful battery: Sheathed and coppered also: To have the highest "practicable" speed and great radius of action. These vessels were recommended for a place on the previous programme.

Twelve gunboats of about 900 tons trial displacement: Sheathed and coppered. These vessels are intended for shallow river service in foreign stations, and are of a type recommended by Admiral Dewey.

Meanwhile a start has been made toward the construction of the cruisers of the *Denver* class, contracts for their construction having been awarded as follows:

U. S. S. *Chattanooga*, Lewis Nixon, Crescent Shipyard, Elizabethport, to be built, in 30 months, for $1,039,966.

U. S. S. *Cleveland*, Bath Iron Works, Bath, Me., to be built, in 30 months, for $1,041,650.

U. S. S. *Denver*, Neafie & Levy, Philadelphia, Pa., to be built, in 30 months, for $1,080,000.

U. S. S. *Des Moines*, Fore River Engine Company, Weymouth, Mass., to be built, in 30 months, for $1,065,000.

U. S. S. *Galveston*, W. R. Trigg Co., Richmond, Va., to be built, in 24 months, for $1,027,000.

U. S. S. *Tacoma*, Union Iron Works, San Francisco, to be built, in 27 months, for $1,041,900.

These vessels have been described in detail in a former issue.

LOSS OF THE U. S. S. CHARLESTON AND BURNING OF THE S. S. PATRIA AT SEA.

To report the loss of an American war vessel is not as agreeable a task as to chronicle the launch of a new vessel, and especially is this so when the loss is an inglorious one, practically in time of peace. As our readers are aware from press reports, the U. S. S. *Charleston* was wrecked on an uncharted reef off the northeast coast of Luzon, Philippine Islands, early in November, and all on board were saved. The *Charleston* was engaged in patrol duty, and while steaming along the coast struck on the reef about 6 o'clock in the morning. It was soon seen that she was fast and would probably become a total loss, and it is likely that only the prompt closing of the water-tight doors prevented her sinking immediately. A heavy sea was on and the vessel was in danger of being washed off into deep water, so that it was decided to abandon her. The boats were provisioned with ten days' rations, and the crew got away carrying their rifles and the two automatic guns. A landing was made on a small island not far distant, and the day following a landing was made on Kamiguin Island, about ten miles distant. It was expected that hostile natives would be met, but, instead, the inhabitants made no disturbance. After waiting for the weather to moderate, a sailboat was sent off in charge of Lt. John D. McDonald, to proceed toward Manila and notify any passing vessel. After some rough weather experiences, the boat's crew sighted the transport *Aztec* in the Lingayen Gulf, November 11, and was towed to the U. S. S. *Oregon*, which was in the vicinity. Her commander at once ordered the gunboat *Helena* to proceed to the relief of the shipwrecked crew of the *Charleston*. In going ashore the *Charleston* appears to have run on a steep bank, as she was almost submerged at the stern, while the bow was high out of the water. Wreckers from Hong Kong will examine the vessel, with a view to salvage.

On the next page a view of the *Charleston* in her peace clothes is given. She was an unarmored steel vessel, being classed as a protected cruiser. She was one of the early ships of the new navy, and, as was the case with several other vessels, her plans were originated in England. She was built by the Union Iron Works at San Francisco, being launched in July 1888, and was first put in commission in December, 1889. Her chief characteristics were as follows: Length, on load line, 312 ft. 7 in.; beam, extreme, 46 ft. 2 in.; draft, mean, 18 ft. 7 in.; displacement, 3,730 tons; indicated horse power, 6,660; speed, on trial, 18.20 knots; bunker capacity, 750 tons; steaming radius at 10-knot speed, 4,256 knots. She was fitted with twin screws, driven by horizontal compound engines, and with Scotch boilers. For defense she had a protective deck, of a maximum thickness of 3 in. Her armament included two 8-in. breechloaders, one forward and one aft; three 6-in. breechloaders on each side, and four six-pounders, two three-pounders and two one-pounders, all rapid-fire, and the usual machine guns. She had one large funnel and two military masts. Her complement was twenty officers and 289 men.

Fire destroyed the Hamburg-American liner *Patria* while on her eastward voyage from New York to Hamburg, November 15. The fire is supposed to have been started in one of the holds by spontaneous combustion, and to have been smoldering for a considerable time before the smoke and flames made it known to the passengers and crew. It broke out fiercely one morning about 10 o'clock, when the vessel was in the English Channel. Fortunately the weather was calm and the boats, containing all of the passengers, were lowered without special difficulty. The Russian steamer *Ceres* shortly after came up and took on board the passengers, carrying them to Dover. The Captain and a portion of the crew remained with the vessel, but finally abandoned her, and she stranded on the coast of Kent, apparently a total wreck. The *Patria* was one of a fine class of twin screw vessels in the regular New York-Hamburg passenger and freight service. She was built at Stettin in 1894, and was of these dimensions: Length, 460 ft.; beam, 52 ft.; depth, 31 ft. 6 in.; gross tonnage, 6,664 tons. She was fitted with twin screws and triple expansion engines, and had all the fittings and appliances of the modern liner. She had accommodations for fifty cabin and a large number of steerage passengers.

Through the courtesy of a subscriber at Cambridge, Mass., we are able to publish a reproduction of a photograph of the Warren liner *Bay State*, the loss of which was reported in our last issue. She was a fine new twin screw vessel, of 6,824 tons gross, built in 1898 by Harland & Wolff, Belfast. Her dimensions were; Length, 490 ft.; beam, 52 ft.; depth, 32 ft. Her home port was Liverpool, England. She was fitted with triple expansion engines and return tube boilers constructed at the builders' yard.

CORRESPONDENCE DEPARTMENT.

Three-wire System of Electric Lighting.

Editor of Marine Engineering:

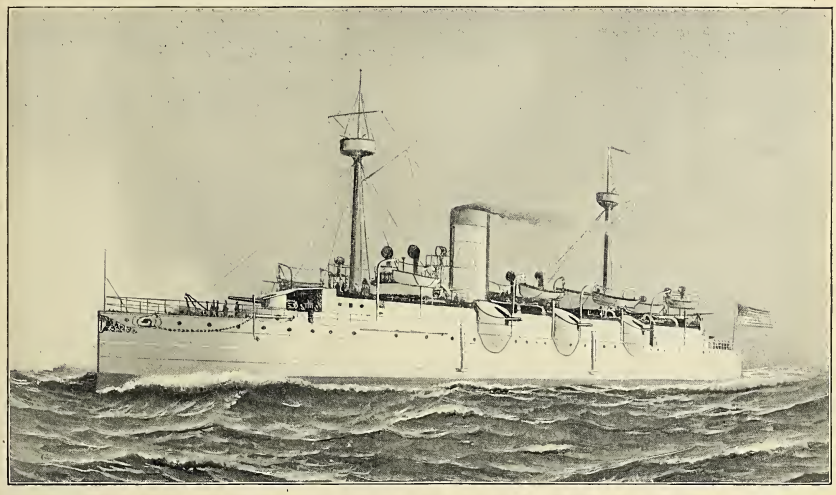
I wish to call your attention to the fact that the method of operating a three-wire system from a single four-pole machine proposed by Mr. Cecil P. Poole in your last issue is not new and as described is utterly inoperative.

With a machine connected up as shown in Fig. 4, the pressure will be equally distributed as stated when there is no load. The effect of a load either on the outer wires or from either outer to neutral is to concentrate the field under the trailing poles, that is, under the last pole of each sign under which the armature conductors pass. Thus under load the pressure under the first pole of each sign would fall to perhaps 75 volts, while under the following poles of each sign it would increase to 175 volts or over, or exactly as much as it decreased under the first-named poles. The two neutral brushes would thus, as shown, be in parallel with a difference of potential of, say, 50 volts between them, and would promptly burn up and the whole machine "lay down."

This is not a prediction, but an exact statement of fact as set forth in several articles in the electrical papers describing tests of machines arranged for working on my multi-voltage systems.

It is possible, by using but one neutral brush and complex balancing field windings to operate a three-wire system and I have a machine in my shop that I have operated in that way, but it proved so difficult to build and to adjust that I let it drop.

(*Continued on page 280.*)



U. S. PROTECTED CRUISER CHARLESTON, 3,700 TONS. WRECKED ON NORTHERN COAST OF LUZON, P. I.

HAM.-AMER. S. S. PATRIA, BURNED IN ENGLISH CHANNEL.

WARREN LINE S. S. BAY STATE, LOST NEAR CAPE RACE.

It would seem to be your duty to point out the error in your article or describe the methods now in use to accomplish the end desired. I would refer you to the Westinghouse dynamos in the lighting plant of the new Union Ry. station at Boston. The machines are quite different from that described by Mr. Poole and cannot be used where the voltage on each side of the neutral must be independently adjusted. The machines were recently described in the electrical papers. (*El. Engineer*, Nov. 11, 1898.)

S. W. RUSHMORE,
Jersey City, N. J.

REPLY.

Replying to the letter above, the writer wishes to point out that nowhere in the article under discussion was any claim made for originality. The editor of MARINE ENGINEERING will recall a conversation in which the writer stated distinctly that the idea is old and that machines based upon this idea had been used in England years ago, though to a limited extent. These two statements effectively answer Mr. Rushmore's rather impetuous denunciation so far as statements go.

As to demonstration, Mr. Rushmore's offered explanation of his own failure to succeed, reminds the writer strongly of the small boy who concluded that a certain physical feat was impossible, because he had tried it vainly. (Not the slightest discourteous intimation is intended.) Mr. Rushmore's statement that most of the total field of two entirely separate pole-pieces will be concentrated under one of them by armature reaction is very rash. That the armature reaction of a modern dynamo will be so enormous as to force any magnetic lines backward out of one core into the next one is an absurd proposition. That the lines will concentrate under the trailing edges of *each* pole-piece is indisputable, but that fact proves none of Mr. Rushmore's claims.

Referring to Fig. 1 herewith, Mr. Rushmore will probably recognize a device used to prevent the congestion of lines under the trailing edges, *t*, *t*. That such a device gives a reasonably stable field no one will deny. Experiments with a machine so built have shown that a third brush can be applied at *m* without

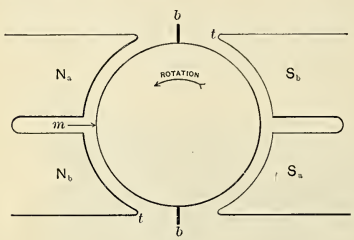


FIG. 1.

sparking, but two midway brushes cannot be used because the halves *Nb* and *Sa* are of unequal strength, producing the result described by Mr. Rushmore. In this case *one coil* supplies both *Na* and *Nb*, so that the armature reaction can unbalance the two halves up to the point where *Nb* becomes saturated. But this is a totally different case from the one in question, though Mr. Rushmore has misapplied the reasoning for this case to the other one.

In Fig. 2, N_1 and S_2 will be of equal strength if their excitation be equal. The armature reaction from — to *n* will be exactly equal to that from — to *n'*, hence each field will be distorted alike, and all of the brushes will require to be moved the same distance from the

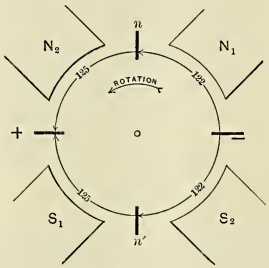


FIG. 2.

theoretical commutating points, which is equivalent to not moving any of them, so far as their inter-relations are affected. Similarly, N_2 and S_1 will be equal in strength, under equal excitation, no matter what (within practical limits) may be the difference between N_1 and N_2, and correspondingly, between S_1 and S_2. The diagram shows a difference of potential between + and *n*, *n'*, of 125 volts, and a difference of 122 volts between — and *n*, *n'*. Will Mr. Rushmore kindly say how *n* and *n'* can be at different potentials either above — or below +? He will probably argue that the potential difference between — and *n* is lower than that between — and *n'*. For this to be true, the armature reaction under N_1 would have to force part of the lines of force created by the coil on that pole to leave it and appear under the pole N_2. In the name of common sense how is such a performance possible?

I have argued the case merely in order to show the fallacy of Mr. Rushmore's reasoning. The whole question might have been disposed of with the simple statement, which can be substantiated, that machines of the sort described have been built and operated without showing the least tendency to "lay down" or manifesting any disquieting symptoms. If Mr. Rushmore would like a design for such a machine, to be "utterly" operative, he can easily obtain it.

CECIL P. POOLE,
New York.

The Hamburg-American Line has repurchased the S.S. *Columbia*, which it sold to Spain before the Spanish-American war, the vessel being then renamed the *Patriota*. The *Columbia* has again taken her place in the express service of the company to New York.

The British Admiralty is experiencing much difficulty in recruiting a sufficient number of machinists, who in that service are styled artificers. Special efforts are to be made to induce skilled mechanics to join.

ENGINEERS' DICTIONARY.—XXII.

Hydrometer—In general an instrument for determining the density of a liquid relative to that of some standard, such as water. In particular an instrument for determining the density of the water in a boiler relative to fresh water. The name *salinometer* is often used in referring to this particular form of hydrometer. As shown in Fig. 80, it consists of two bulbs with a stem above. The lower bulb is weighted with shot in order to keep the instrument upright in the water, while the stem is provided with one or more scales for reading the density according to the depth to which it sinks in the water. Ordinary sea-water has about one part in thirty two of solid matter, and the scale is usually marked so that in sea-water the instrument will sink to the mark 1, in water having twice the relative amount of solid matter to mark 2, etc. The reading on the scale then shows the number of parts of solid matter in thirty-two of water. As the reading would depend somewhat on the temperature also, it is customary to provide three scales, one arranged for 210°, one for 200°, and one for 190°. The water being drawn from the boiler rapidly cools down through these temperatures, and at one or more of them the desired test may be made.

Fig. 80.

Hydraulic Test—A pressure test applied to boilers or other closed chambers, in which water is forced by a pump into the boiler or chamber until it is full and the pressure has risen to the desired point. The test pressure for boilers is usually one and one-half times the working pressure.

Indicated Horse Power—The power developed by the steam or other working fluid in the cylinders of an engine. This power is computed from the indicator cards, and is usually denoted by the initials I. H. P. See under Horse-Power.

Indicated Thrust—As explained under Horse-Power, work is measured by the product of force by distance or motion, while horse-power is measured by the work done per minute of time. Indicated horse-power may therefore be considered as the product of a certain thrust or force multiplied by the distance through which the ship is moved per minute. Such a force is called the *indicated thrust.* It is, therefore, equal to the indicated horse-power reduced to foot-pounds and divided by the speed of the ship in feet per minute. If there were no loss of power by friction in the engine, and if the propulsive action of the propeller caused no loss of power, the actual thrust at the thrust block would be the same as the indicated thrust. In the actual fact there is necessarily loss in both these ways, and the indicated thrust is therefore greater than the actual thrust in the ratio in which the indicated horse-power is greater than the thrust horse-power. The rule for finding indicated thrust is, therefore, as follows: *Rule*—Multiply the I. H. P. by 33,000 and divide by 101.3 times the speed in knots, or by 88 times the speed in miles per hour. This will give the indicated thrust in pounds, after which it may be reduced to tons by dividing by 2,240 or 2,000, as may be desired. Example: I. H. P. = 1,800, speed = 13 knots. Indicated thrust = (1,800 × 33,000) ÷ 13 × 101.3 = 45,100 lbs. = 20.1 tons.

Indicator Card—The card or diagram obtained by means of the indicator. A typical card is shown in Fig. 81. *A* is the beginning of the stroke, *B* the point of cut-off, *C* the point of exhaust opening, *D* the end of the stroke and beginning of the return, *E* the point of exhaust closure, and *F* the point of steam opening for the next stroke. *AB* is called the *steam* line, *BC* the *expansion* line, *CDE* the *exhaust* line, *EF* the *compression* line, and *FA* the *admission* line. The line *PQ*, drawn

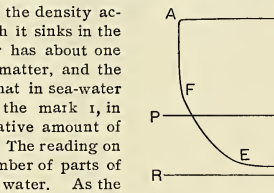


Fig. 81.

when the space below the indicator piston is shut off from the engine cylinder and connected to the air, is called the *atmospheric* line. A line *RS*, drawn parallel to *PQ* and at a distance below it, representing to the scale of the diagram the atmospheric pressure, or 14.7 lbs. per square inch, is called the *absolute pressure* line. The distances from this line to *ABCD* give the value of the total forward pressure at various points of the stroke, while similarly the distances from *RS* to *DEF* show the values of the back pressure at similar points. The area of the diagram divided by its length will give the mean height, and this, multiplied by the scale of the spring, will give the *mean effective pressure* for the stroke. A similar diagram from the other end of the cylinder will give like information for that end, and the mean for the entire revolution may thus be found. The use of this in computing power has been described under Horse-Power.

Indicator Cock—A form of cock for connecting the indicator with that end of the cylinder from which the card is desired. Where an indicator is provided for each end of the cylinder, a *two-way* cock is required for connecting the indicator with the air or with the cylinder, as desired. Where but one indicator is provided for both ends of the cylinder a *three-way* cock is required for connecting the indicator with the air or with either end of the cylinder, as desired.

Indicator Connections—A general term relating to the piping and fittings connecting the indicator with the cylinder.

Indicator Motion—A general term relating to the gear used for giving motion to the indicator drum.

Two 20-knot cruisers are now under construction at the Bergsund Works, Stockholm, for the Swedish Government, and a battleship, the *Dristigheten,* is also being constructed at Lindhlomen, Gothenburg. These vessels are to be fitted with water-tube boilers of the Yarrow type.

NEW PUBLICATIONS.

PROBLEMS IN MACHINE DESIGN. By Charles H. Innes, M.A., Engineering Lecturer at the Rutherford College, Newcastle-on-Tyne. Second Edition, 1899. Technical Publishing Co., Manchester, England. Size, 5 by 7 1-2. Pages, 258. With 200 diagrams. Cloth, 4s. 6d.

This book has been especially prepared as an aid to the student for the honors stages of the British Science and Art and Technological Examinations in Machine Construction and Mechanical Engineering. It is, therefore, concerned with the broad field of structural machine design with more especial reference to the chief elements which enter into machines and engineering works, rather than with the design of complete machines, which, according to the author's preface, he hopes to deal with at a later time in a separate volume.

The book is divided into twenty-two chapters, each one dealing separately with some one sub-division of the subject. The first few chapters are introductory in their character, and deal to a considerable extent with graphical statics and other principles of mechanics which are required for treating the subject. In Chapter IV some of the more complex forms of riveted joints are discussed, and illustrative examples are worked out showing their relations to the rules of the *British Board of Trade*. Cottered joints, connecting-rods, piston-rods and shafting, occupy the following ten chapters. These chapters are to be especially commended for the clear way in which the subject matter is presented, for the close connection which the author makes between actual practice and the formulæ given, and for the large amount of data given in tabular form and furnishing a series of illustrative values for the leading dimensions of these features, drawn from both British and American practice.

The following chapter deals with expansion valve gears, in which the leading types of gear are explained and discussed by the aid of the Zeuner, Reuleaux and elliptical diagrams. This chapter is perhaps open to some criticism by reason of the too great reliance which seems to be placed on the diagrams, and on purely analytical investigation. Few valve gears can be designed in a thoroughly satisfactory manner without the aid of a model or of some method for obtaining point by point the actual motion of the valve relative to the piston, including all secondary causes of disturbance. The use of simple diagrams alone must always be considered as a first approximation only, and the attempt to deal with secondary disturbances by analytical methods is entirely too cumbersome to admit of application in a drawing office. The marine engineer will also note the absence of all reference to the Walschaert gear, a form of valve-gear which is attracting some attention in the marine field at the present time.

In the following chapter the subject of inertia forces and balancing is taken up. This chapter is less satisfactory than several of those which precede, partly because the author in his efforts at condensation has omitted all fundamental explanation and introduces trigonometric equations and other results without a word of explanation as to their derivation or significance. This entire chapter is written in too condensed a style for the average student, and it is doubtful if those who are not already familiar with the subject could gain much additional idea from the presentation here given. A word of caution relative to the attention which this subject is at present receiving may properly be noted at this point. It must not be forgotten that it is quite possible to overestimate the relative importance of balancing, and to overdo the matter, especially if the system leads to serious changes in the accepted and customary crank angles and other features. In no case with the moving parts all on one side of the shaft can the balance be perfect, and in the opinion of the reviewer all significant balance may be obtained by an appropriate adjustment of crank sequence, cylinder sequence, and valve movement relative to piston, with, of course, aid from the adjustment of weights of moving parts when convenient.

Following are chapters on governors and on the design of spiral springs. In these chapters the subject is discussed in more detail, and the treatment is more satisfactory.

The design of air vessels for pumping machinery is considered in the next chapter, a subject which is too often omitted from all consideration, both by the writers of books and by the builders of pumping machinery. The remaining chapters deal with fly-wheels and with the diagram factors and ideal cards of compound engines.

Taken as a whole the book contains very much of value to the student of machine design, both in the range of topics treated, and in the large amount of actual data given. Throughout the book, marine practice receives more attention than is usually given to it in works not especially relating to this field of design, and it will be of corresponding value and interest to the designer of marine machinery. The chief fault of the book lies in the style of the author, which is not always clear, and in an effort at condensation which has resulted in gaps which many students would fill in only with difficulty. It is true that the author expressly notes in his preface the omission of much of the elementary part of the subject, but it may be questioned if he has not thereby decreased the usefulness of his work for the average student who may not have a more elementary work at hand, or who may not know where to turn quickly to fill the gaps occurring in the present work.

The illustrations throughout the text are numerous, and for the most part well executed, though occasionally one is found which has suffered either in the reproduction or printing.

The Practical Engineer's Pocket Book for 1900, published by the Technical Publishing Company, Manchester, England, has been issued and is for sale by D. Van Nostrand Company, New York. This little annual contains a valuable amount of data for ready reference and is sold at a very low price, 1 shilling and 6 pence. It has been increased in size and in the number of subjects covered. It is chiefly intended for mechanical engineers and is, of course, written from the standpoint of British practice. It contains, however, much information indispensable to the marine engineer.

The series of papers on the Slide Rule written for the *American Machinist* by F. A. Halsey, has been published in book form by D. Van Nostrand Company, New York. Price, 50 cents.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

In answer to the query of "An Inquirer."

A.—When a ship is turning under the influence of the rudder the point on the ship about which the swinging motion takes place is usually well forward and near the bow. Hence a rudder located at the bow has a very much shorter arm or leverage than one at the stern, and it is due chiefly to this fact that a rudder at the bow is very much less effective than one at the stern. In fact, the bow is the very worst place at which a rudder can be located.

Due to this and other reasons it is customary in ferryboats to lock the forward rudder and use only the one at the stern. It thus results that two independent sets of steering appliances are fitted, each rudder being connected with the pilot house on the opposite end of the boat. The connection of each rudder to both wheels would result in a further complication of tiller ropes and leads which of itself would be quite undesirable.

In the case of the catamaran which you mention, it will be undoubtedly much better to follow the same plan, and to have the rudders independent, and so fitted that when going in either direction those at the bow may be locked, and those at the stern brought into use.

Q.—Please publish a rule for finding the collapsing pressure on a corrugated furnace. Is there any rule for finding what the length of furnace crowns should be? TEXAS.

A.—The U. S. rule for finding the safe working pressure on a corrugated furnace is as follows:

Rule.—Multiply the thickness in inches by 15,000 and divide by the mean diameter in inches,

$$or\ Pressure = \frac{15000\ T}{D}$$

This rule is based on experimental determinations of the collapsing strengths of corrugated furnaces, and is intended to give a factor of safety of from 5 to 5½. Hence, taking a fair value from the experimental results, we have the following rule for finding the pressure at which we should expect collapse:

Rule.—Multiply the thickness in inches by 80,000 and divide by the mean diameter in inches,

$$or\ collapsing\ pressure = \frac{80000\ T}{D}$$

Example.—Thickness = ½ in., mean diam. = 40 in., then the probable collapsing pressure would be not far from:

$$p = \frac{80000 \times 1}{40 \times 2} = 1000\ lbs.$$

With corrugated furnaces the length does not enter into the formula for strength, and so far as strength is concerned, there is no limit whatever on the length of furnace.

Q.—Will you please inform me as to when an engine will make the most revolutions—going with a strong tide or against it? A. D. P.

A.—There seems to be no reason to expect, with the same steam pressure, any marked difference in the revolutions, whether steaming with or against the tide. There are reasons, based on abstruse mathematical principles, for expecting a slight increase in revolutions when running in either direction in a tide-way as compared with the revolutions in absolutely still water.

Q.—Kindly explain what is meant by the "Russian method of vise work" which was used at the Naval Academy for the instruction of cadet engineers?

OLD SUBSCRIBER.

A.—The so-called Russian system of vise work for manual training consisted of a carefully graded series of exercises, each involving some simple or elementary operation with hand tools, the whole intended as a training in the elements of vise and bench work. In such a system the exercises are done simply as an end in themselves, and they have no relation to any finished product, and are not intended to be of direct use in themselves, except as they afford an opportunity for training the muscles and eye of the student.

As illustrations of such exercise the following may be mentioned:

Chipping a small block of cast iron to a flat surface.
Chipping a groove or key way in such a block.
Filing up such a surface flat and true.
Filing up two surfaces at right angles to each other.
Filing up two surfaces parallel to each other.
Filing up two surfaces tapering by any given amount.

The name Russian was given to the system on account of the examples of work from a manual training school in St. Petersburgh, which were exhibited and attracted considerable attention in this country at the time of the Centennial Exposition of 1876.

Q.—In your October issue, I note the following statement in reference to a steam engine: "We must remember that it is the heat that really does the work and that the steam or water is only the carrier for it." Now take the following case: A is an old-fashioned plant, and where fuel is little or no object. When the boilers were first installed they were calculated for a pressure of 100 lb. per sq. in., but through old age the pressure has been reduced to 70 lbs. per sq. in., at which pressure the engines will not develop enough power to do the work required of them. Now if it is really the heat that does the work, could he not fit a superheater and heat the steam so that as many heat units will pass into the engine now at 70 lb. as there were formerly at 100 lb., and if so, will the engine do as much work as at the original pressure, and if not, why not? J. G. C.

A.—It is true that by superheating the steam at 70 lb. pressure, one pound weight of steam could be made to contain as much heat as one pound of ordinary steam at 100 lb. pressure. It would require only about 15 degrees of superheat to accomplish this. It is also true that such steam used in the *same engine* would not develop the work which would be given by ordinary steam at 100 lb. pressure with the same amount of heat per pound of weight. It is also true that it is the heat alone which does the work.

Now let us examine briefly the seeming contradiction.

In the first place the superheated steam at 70 lb. pressure would not give as much work in the *same engine* as ordinary steam at 100 lb. pressure, for the reason that it would be less dense, and hence the engine would take in a smaller *weight of steam* at each stroke. If the engine were of such size, for example, that at each stroke one pound weight of steam at 100 lb. pressure would enter, then only about .73 of one pound weight of the superheated steam at 70 lb. pressure would enter per stroke, and hence for this reason, if no other, less work would be done. To be fair to the superheated steam it would be necessary to give it a larger engine so that cutting off at the same point in each, the same weight of steam will be admitted per stroke. If this were done it would be found that the engine with the superheated steam at 70 lb. pressure would develop very nearly or perhaps quite as much work as the smaller engine using the same weight of ordinary steam at 100 lb. pressure.

But there is still another difference between the two sets of conditions which may effect the result. This is the difference in temperature. To appreciate the influence of this feature we must remember that while it is the heat alone which does the work, it is not only a question of how much heat the substance has when it comes to the engine, but also of how much of this heat can be transformed into work, and how much must be allowed to escape with the exhaust and in other ways. If we were able to make an exact heat balance we should find that the heat which is transformed into work plus the amount which escapes with the exhaust and in other ways will exactly equal the amount which comes into the engine. Now, it is clear that the greater the amount of heat which can be transformed into work, the better the efficiency of the engine. Usually this amount varies from 5 to 20 per cent. It follows that with a given amount of heat to start with, one engine may transform 5 per cent. into work, another

10 per cent., and another 20 per cent. Or with the same amount of heat to start with, one engine may give back twice, three times, or even four times and more the work of another, simply by reason of its higher efficiency.

In this case, therefore, the question is as follows: Of two engines each using the same weight of steam with the same heat per pound, one superheated and one ordinary steam, which will be able to make the better use of the heat—which will give back the larger return in the form of work? Without going into details it can be said that other circumstances being the same, the higher the initial temperature the better the efficiency, and the more work returned for the same amount of heat. On the other hand superheating tends to prevent a loss in the use of ordinary steam due to the condensation in the cylinders.

The ordinary steam in the question under discussion will have the advantage of a higher temperature, while the superheated steam will have the advantage of saving a part of the cylinder condensation. How the final result would balance off could only be determined by actual test, but in the case you describe the difference would certainly be very small.

In general it may be seen that heat is all that is used by considering the case of a condensing engine without leak or water wasted. In such an engine the same water would be used over and over again without loss, while the coal pile would need to be constantly renewed. *This shows that it is heat which is being expended and not water or steam.*

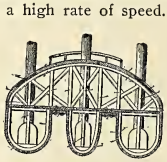
The same general principles are true no matter what the medium used, whether heated air in an air engine, or heated gas in a gas or vapor engine. It is heat, and heat alone from which we derive the work in all such forms of motor.

SELECTED PATENTS.

(Subscribers are notified that the publication of a patent specification in this column does not indicate editorial commendation or condemnation.)

634,814. Hull. J. W. Glaholm, Nanaimo, Canada.

CLAIM.—To provide a light draft vessel capable of being driven at a high rate of speed. Hull is formed



in three parallel sections converging into a common bow. The deck is arched and merges with the outer sides of the outer hull sections.

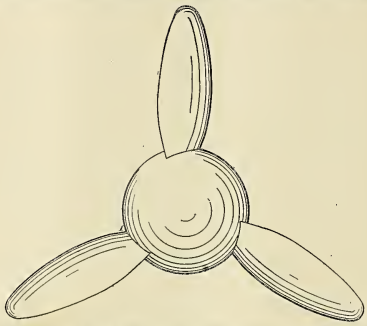
634,028. Means for launching life-boats from vessels. James Pollitz and E. H. Cox, New York, N. Y.

CLAIM.—The boats are supported over the deck of the vessel by long arms, which are hinged to the out-

side of the body of the vessel. When the arms are floated, the boat will be floated at a point beyond the wash of the vessel.

634,368. Screw-propeller. Thomas Pounds, Plymouth, England.

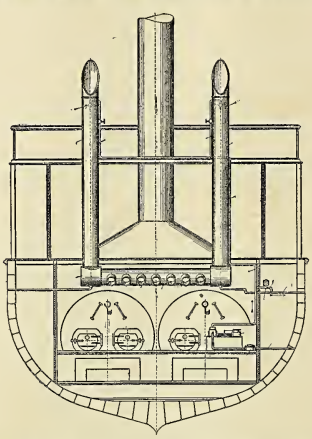
CLAIM.—To obviate the negative pressure due to the thickness of the blades, which is exerted upon the for-



ward faces of the blades near their leading edges. The driving-face is of uniform pitch from its following edge to where the blade is thickest; and of gradually increasing pitch from there to its leading edge.

634,563. Apparatus for ventilating and cooling stoke-holds of steamships. Max Robitschek, Vienna, Austria-Hungary, assignor of one-half to Leo Von Herz, same place.

CLAIM.—Water atomizers are so arranged in the upper parts of the usual ventilation shafts as to produce a downwardly-directed jet of spray, which sucks in the air from without and cools and moistens it by partial evaporation. The lower ends of the ventilator



shafts open into water separators having inclined bottoms and baffle plates, against which the current of air and spray impinges. These separators communicate with chambers arranged in the ceiling of the stoke-hole and provided with a number of outlets for the cooled air.